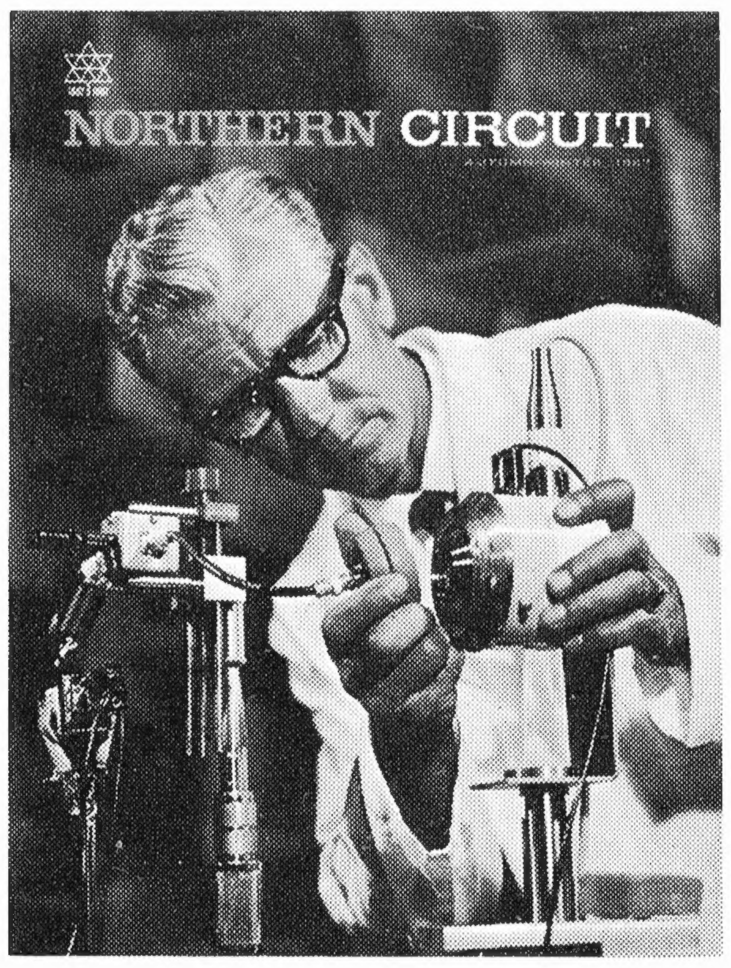
1867 1967

NORTHERN CIRCUIT

AUTUMN/WINTER 1967





Inside an anechoic chamber, a scientist at Northern Electric laboratories in Ottawa works on a new telephone microphone. For more details, see page 14.

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Infrared

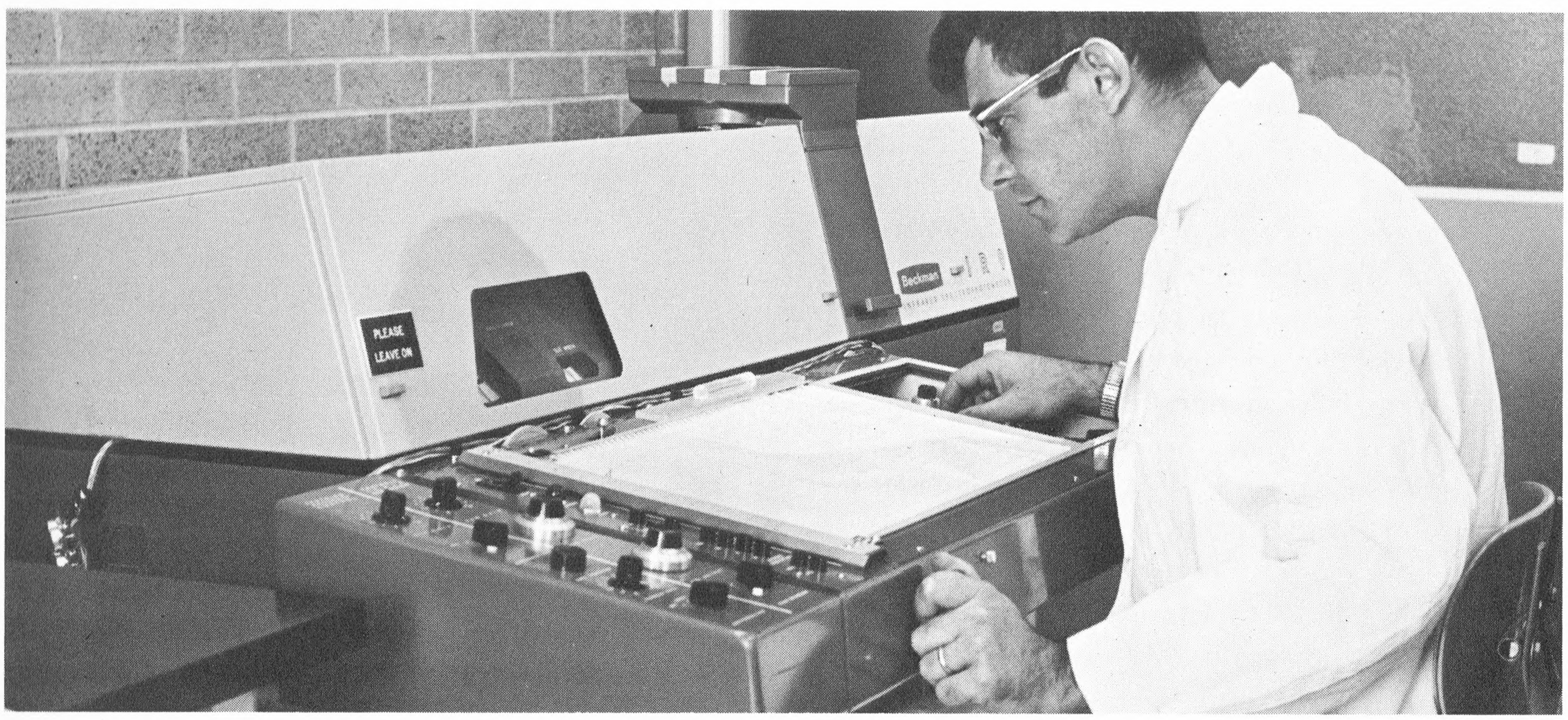
by J. E. Mann

The amazing invisible light

It's similar to ordinary light . . . but can't be seen. It's definitely there though, working hard for industry, medicine, engineering and others. It spots hidden faults in complex electronic gear. It measures hot steel slabs as they rumble through a rolling mill. It reveals heat losses in buildings or the amount of moisture in paper racing through a paper machine. It helps diagnose cancer, and detects air turbulence ahead of swiftly moving jets. These are only a few of the myriad uses for the amazing invisible light known as infrared, or IR.

Essentially, infrared light is radiant energy which appears just beyond the visible light in the electro-magnetic spectrum and travels at the speed of light.

Because it is invisible, infrared radiation can only be detected by sophisticated instruments. Their operation is made possible by the simple fact that all objects radiate infrared energy. To record this energy, such instruments as infrared radiometers have been develop-



This infrared spectrophotometer is the key instrument in determining impurity concentrations in semiconductors, ceramics and ferrites at N.E. laboratories.

ed, and more recently, the infrared camera, an amazing device that takes photographs of heat patterns called thermograms.

A radiometer is a device to collect infrared radiation and convert it into an electrical signal that can be amplified, measured and recorded.

A refinement of this device is the infrared camera like the one developed by Barnes Engineering Co. of Stamford, Connecticut. It takes pictures of the surface temperature distribution of an object. The thermogram obtained is strikingly similar to a conventional photograph except that the various shades indicate temperatures. Black areas are "cold", white areas are "hot" spots on the object. Shades of grey in between indicate various temperature levels.

SPECIAL APPLICATIONS

One of the early applications of infrared detectors was in a sniperscope scanning device used during World War II. No matter how dark the territory, or how well the enemy was camouflaged, he was apparent on the eyepiece of a rifle's scope. An infrared beam was sighted along the rifle and the reflected infrared energy was picked up by the detector, then converted by an image tube into an equivalent picture in the visible wavelength region.

It is interesting to note that many movie scenes apparently taking place at night are shot as infrared photographs in daylight to create the illusion of nighttime. A special film sensitive to infrared radiation may be used along with sophisticated filtering techniques.

In the scientific field, infrared devices play an important role. Measuring the heat emitted through the human skin at various points on the body has proved valuable in the diagnosis of tumors, arthritis and also in observing the effects of treatment.

By pictorially presenting the surface temperature patterns in this new science called thermography, it has been possible to detect early cancer in human placental locations. Experts in the field see thermography as a special tool in the detection of breast carcinoma and vascular disturbances.

Thermography is based on the fact that the average internal temperature of the human body remains essentially unchanged in health at about 37 degrees Centigrade. The skin temperature, however, fluctuates widely, depending on various factors, such as, increased heat production of tissues, vascular control abnormalities, local effects of systematic changes and others. Thus a study of the heat pattern distribution of the human body, made visible by the infrared scanners, assists medical experts in their diagnosis.

Infrared energy also plays an interesting role in the analysis of chemicals. When shooting invisible light through a gas compound, the compound absorbs energy of a very specific wavelength and, since each com-

An invisible light transmission unit like this one sent stock quotations from the Montreal Stock Exchange to the Canada Pavilion during Expo '67.



pound has a special absorption pattern depending on its molecular structure, the infrared analyzer becomes a valuable tool. It is used, for example, in the petroleum industry to detect and identify impurities in a product stream.

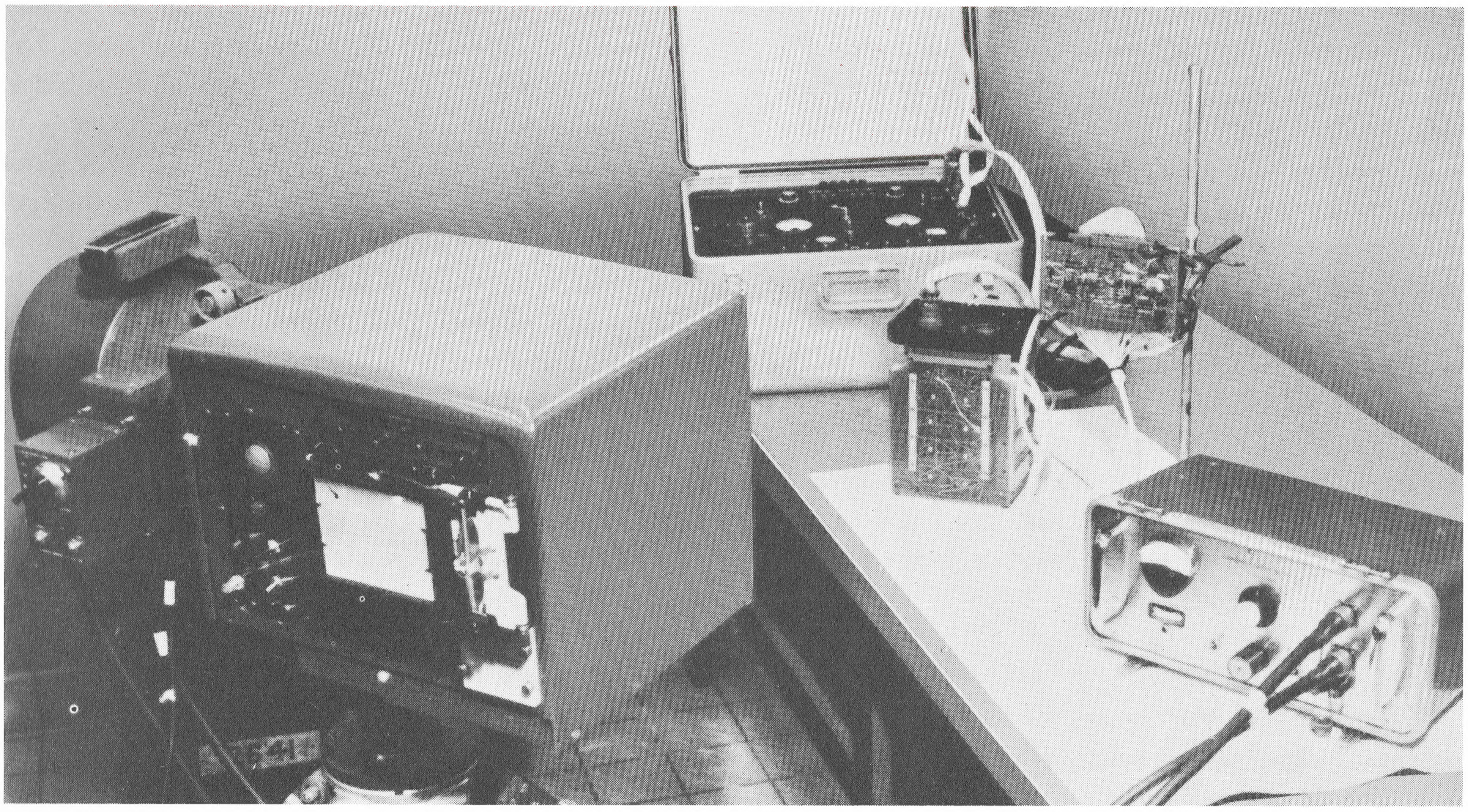
In another area of application, scientists are using infrared detection equipment and infrared film from an aircraft to monitor diseased plant areas in a test field of potatoes. In this plant pathology research, the diseased areas show up black on the aerial photograph; and to test out the technique, a ground view is also taken with infrared film of the test section. The dark plots in the picture show up against the healthy growth — which appears white — and the infrared photographs are used to document the spread of the disease in the test field involved. Fungus disease can be artificially introduced to certain plots to test the efficiency of various fungicides.

IR AIDS INDUSTRY

In industry, IR applications are unlimited: infrared radiation from electronic components, for example, is being used to determine whether a circuit is operating correctly and at the proper design levels, or whether some defect causes overheating or other malfunction.

A Canadian-developed infrared instrument recently made its appearance. Capable of detecting temperature changes of only one degree Fahrenheit at a distance of 65 feet, it is expected to find use among electrical utilities which are frequently confronted with the problem of power interruptions caused by failure

Typical infrared camera set-up for making thermograms of printed circuit modules. Photo courtesy of Barnes Engineering Co., Stamford, Conn.



of high voltage line joints. Since such faulty joints develop sufficient resistance, overheating occurs and subsequent failure. With the portable instrument it is easy to find such trouble spots and to take corrective action. The instrument was developed by the National Research Council of Canada and is understood to be under consideration for manufacture by one or two commercial firms.

NORTHERN ELECTRIC USES IR

At the Northern Electric Laboratories, the use of infrared instruments is a necessary scientific tool to carry out research in the solid state fields. For example, an infrared spectrophotometer is employed to examine and determine the characteristics of semiconductors, ceramic and ferrite materials and to define the impurities present. In the instrument, a ceramic filament produces a spectrum of light which is passed through the material under test. A series of prisms extracts the infrared light that is not absorbed in the material and this information is then read out in the form of a strip chart recorder. The information is then converted to digital form for rapid analysis of the measured parameters.

Infrared light has also a wide range of application in Northern's chemical electronics research. Sophisticated infrared-sensitive solid state temperature controllers are the key instruments in the growth of single crystals of sapphire. The infrared device detects changes in temperature by sensing the infrared emissions from the molten area in the crystal.

At Northern's Advanced Devices Centre in Ottawa, extensive use is made of infrared devices as a production aid. The thickness of epitaxial layers is measured as part of the process in the manufacture of transistors and integrated circuits.

OTHER IMAGINATIVE USES

Weather studies and forecasting have also been placed on a much more precise basis with the help of invisible light. The Great Lakes Investigation Unit of the Department of Transport in Toronto is gathering fast and reliable water temperature data over the Great Lakes by using infrared radiation thermometers mounted in aircraft. The data obtained assists forecasting of meteorological conditions over the lakes and adjacent land areas.

Fire fighters are also looking to invisible light in their annual battle against forest fires. Infrared detectors carried in special pods on forest patrol aircraft pinpoint the location of incipient fires while they are still small and easily extinguishable by water bombers or nearby ground crews.

In recent tests, a patrol plane flying overhead was even able to detect the heat emission from a backyard barbecue.

The mapping of ocean temperature with invisible light is a useful aid to commercial fishermen. Studies by government agencies in the U.S. have determined that certain species of fish prefer particular water temperatures and to find where various schools of fish are congregating, it is only necessary to map the ocean's temperatures. With the use of infrared gear aboard an aircraft hundreds of miles can be charted in a single day.

Perhaps one of the most exciting developments in the use of invisible light is sniffing out the mysterious CAT. This Clear Air Turbulence phenomenum still baffles scientists, and its destructive power is suspected of having been the cause of three recent plane crashes in clear sunny weather. CAT strikes without warning apparently, and airborne radar gear cannot detect it.

The National Research Council of Canada in Ottawa, however, is making great strides in finding a CAT detection system. A specially equipped T-33 jet trainer with infrared sensing gear is being flown all over the continent hunting the mysterious CAT.

The infrared spectrometers being used on this plane are reported to give warning of clear air turbulence as far as 30 miles away. This would be enough to warn airline passengers to fasten seat belts and for the pilot to take evasive action if required. Existing infrared equipment has a reach of about 8 miles, but design

refinements have improved this range to about 30 miles. The infrared device detects temperature variations of 5 to 6 degrees Centigrade, according to NRC. It relies on the fact that the CO_2 content of air varies little with altitude and by measuring its temperature, sudden variations...meaning turbulence...can readily be detected.

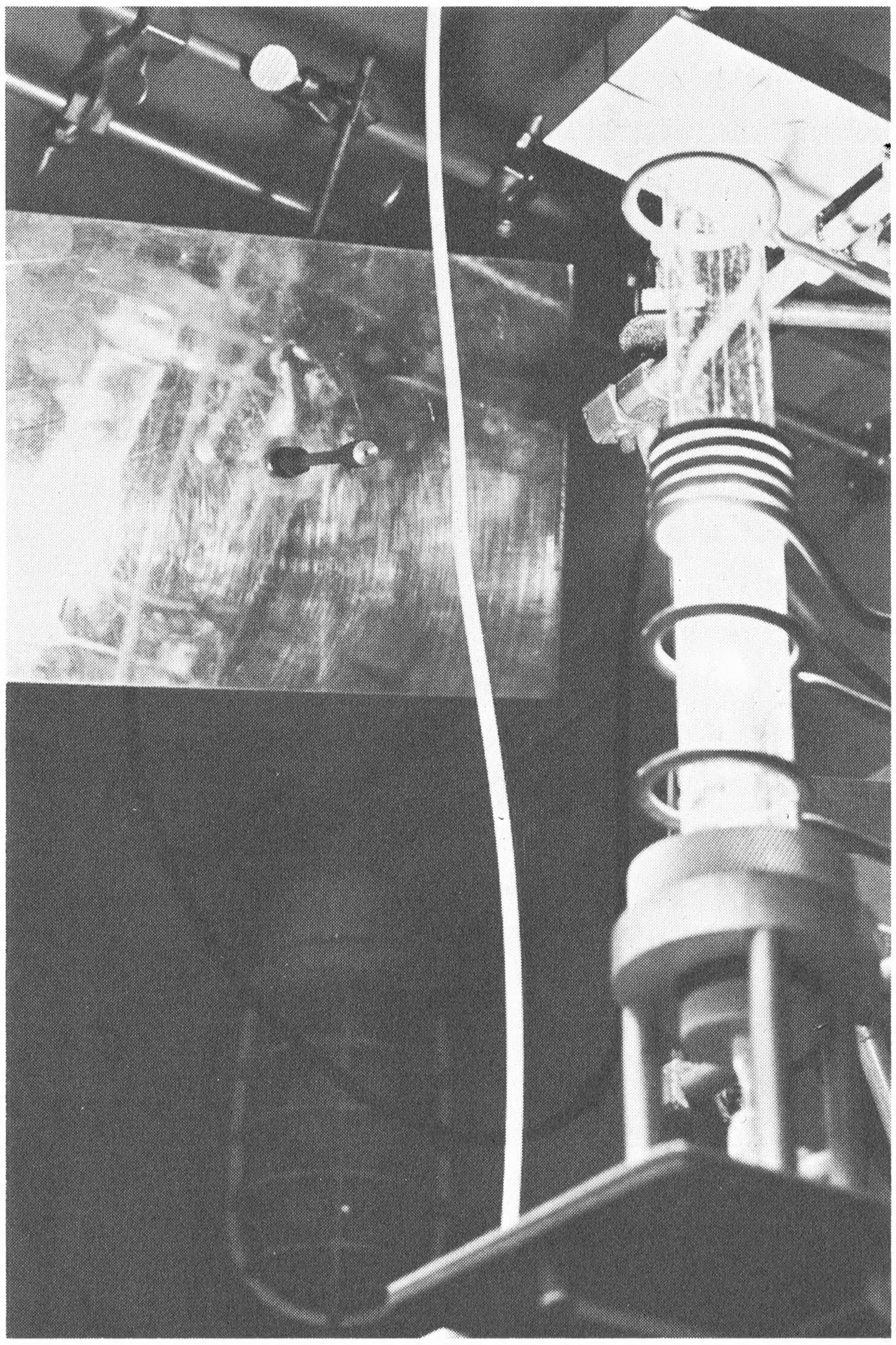
In down-to-earth situations infrared analyzers are now getting into the act to check exhaust emissions from automobiles, to help fight air pollution. Equipment already exists which is portable and can readily be installed in garages, mobile test units and similar equipment.

The glamor achievement for invisible light is of course the infrared camera. This unique "gadget" can produce within a matter of minutes a picture-like display of thermal gradients. Focused on a turbine generator it indicates over-heating; focused on a helicopter anti-icing element it shows the efficiency of heating element spacing; focused on a printed circuit it points out faulty solder joints; focused on a human being it leads to the design of better arctic clothing; it has also shown its usefulness as a diagnostic tool in medicine. The IR camera can be used as a non-destructive inspection and testing tool as well.

LOOKING AHEAD

For the future, more and more new tasks will be found for infrared light. Indicative of trends is the transmission unit that was installed by IBM at Expo '67. There an invisible light beam was used on an experimental basis to transmit large amounts of data from one point to another. One beam carried stock quotations from the 19th floor of the Montreal Stock Exchange to closed circuit television units in the Canada Pavilion. Another beam formed the connection between the IBM computer room in the Canada Pavilion and the Man the Producer Pavilion a half mile away. This beam carried information to and from IBM graphic display terminals at very high speed. Requiring less power than a 10 watt light bulb to operate, this unique method of transmission was of course not a laser beam, but a completely harmless invisible light beam which used a telescope to focus the beam of light on the receiving unit.

This was but one example of the work that is going on in research establishments and laboratories around the world. We can be sure that invisible light will soon be with us on a much larger scale and although invisible, its achievements will be evident for all to see.

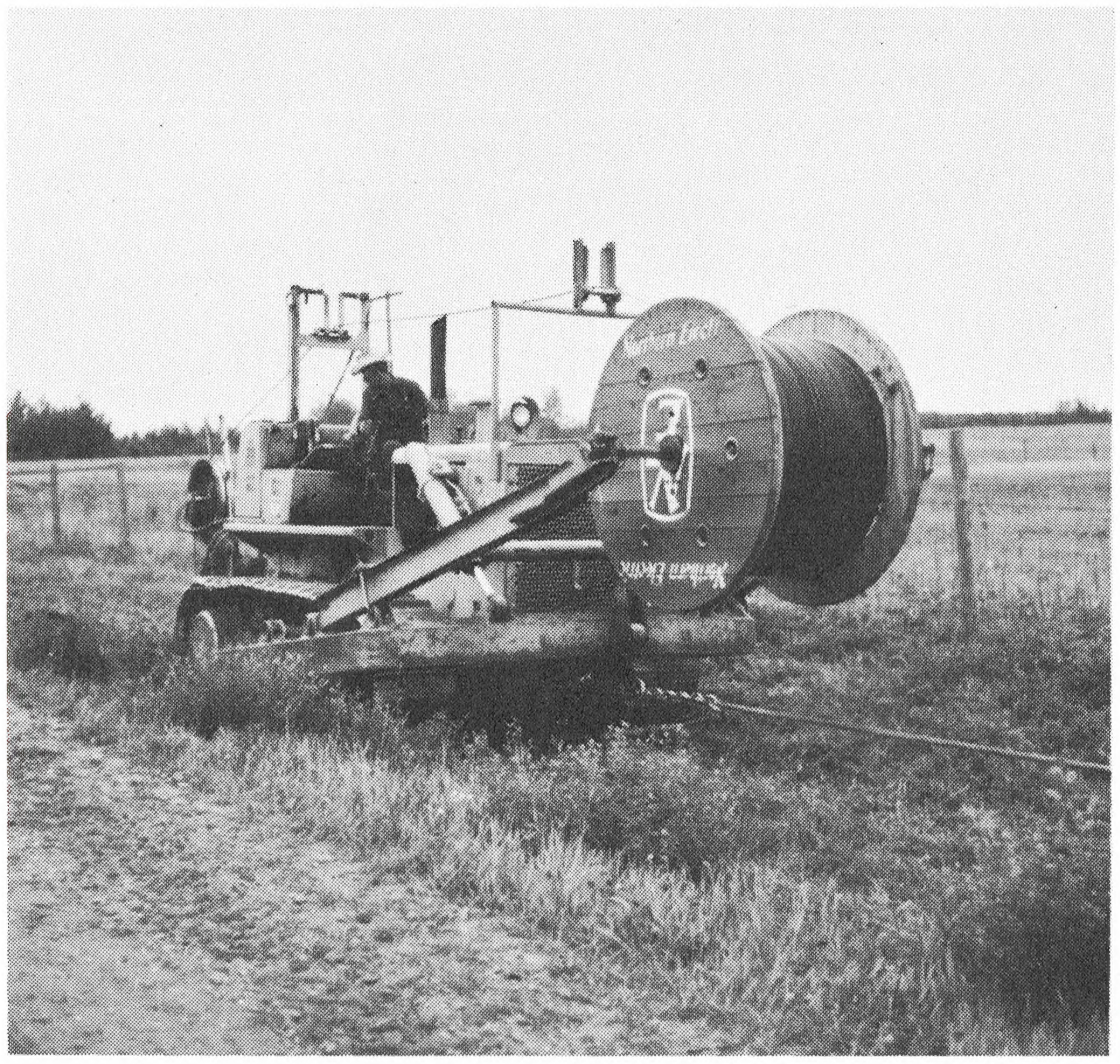


An infrared-sensitive solid state temperature controller (pointed object protruding from shiny plate surface) keeps a watchful eye on the temperature of sapphire crystal growing apparatus at Northern Electric laboratories.

Operation Underground

by W. A. Wardrop

Alberta Government Telephones' buried cable program.



Sometimes the cable-laying machine has an easy job . . .

In 1964, Alberta Government Telephones launched a $60 million rural buried cable program which is referred to familiarly as "Operation Underground". This gigantic scheme calls for the replacement of existing aerial plant in rural areas and for the installation of buried plant in new rural construction. The program will not be considered complete until everything economically practical is buried. At that time, AGT will boast one of the most modern rural telephone networks in Canada.

In the past, a rural party line often served up to 20 subscribers. In Alberta, rural subscribers can look forward to four-party line service. They will be competing with only three other neighbours when they wish to call the family doctor or drug store; in addition, they will be guaranteed more reliable service plus improved quality. Gone from the landscape will be thousands of miles of open wire lines and unsightly telephone poles. The hunter also will no longer be able to sharpen his aim by shooting at glass insulators atop the poles.

With buried cable, line damage is practically eliminated. The lineman need worry no more about heavy sleet, snow storms or high winds. His only worries will occur when someone ignores the sign that requests a call to AGT before digging or when the pesty gopher goes to work. AGT cable is one of his favourite snacks.

Technological advances in communications were a contributing factor in AGT's decision to proceed with this vast project. Improvement in cable design has reduced "sound loss" through the long stretches of cable required in rural areas. Other factors have been the development of the voice frequency repeater, dial long line units, polyethylene insulated cables and the improvement of the telephone itself.

Although it is recognized that cable is initially more expensive than open wire from a material and installation viewpoint — in the long range view the lower maintenance cost tends to balance out the cost differences. AGT feels that underground cable is a valuable addition to the communications system.

The buried cable program begins with the Rural Development section who make contact with every farmhouse in the area, and plot the location of interested parties on a map. This information is given to engineers who carry out transmission checks, and order the required central office equipment. Outside Plant Engineering — Rurals then measures and checks out the planned route and draws up the plans. Bids for the burial of this underground wire and cable are submitted by individual contractors in the early spring, and plowing begins as soon as ground conditions are favourable. The ploughing and burying operations are carried out by these contractors under the supervision of an AGT field engineer, and two AGT plant inspectors.

On an average day a crew is able to plow up to seven miles of cable, but on one record day, over 20 miles were ploughed. Problems arise in areas where rivers, sloughs and muskeg are prevalent and, in such

areas, the mileage covered is far less than on flat, dry land. Muskeg conditions have, at times, resulted in several days work being lost, merely to recover a "cat" put out of commission.

In addition to their rural cable burying project, AGT are also carrying on a dial conversion program. Where possible, these new dial conversions are being served by underground cables. Many of the areas converted to dial before the advent of this program will be considered for conversion to buried distribution at a later date.

When the buried cable plant has been completed, it is expected that 60,000 subscribers will be provided with four-party, buried service.

Since the introduction of the program, more than 19,000 subscribers have received this service. In addition, buried service is available to approximately 9,300 prospects. A total of 235 mutual companies in Alberta have accepted integration into AGT, leaving 782 for future development.

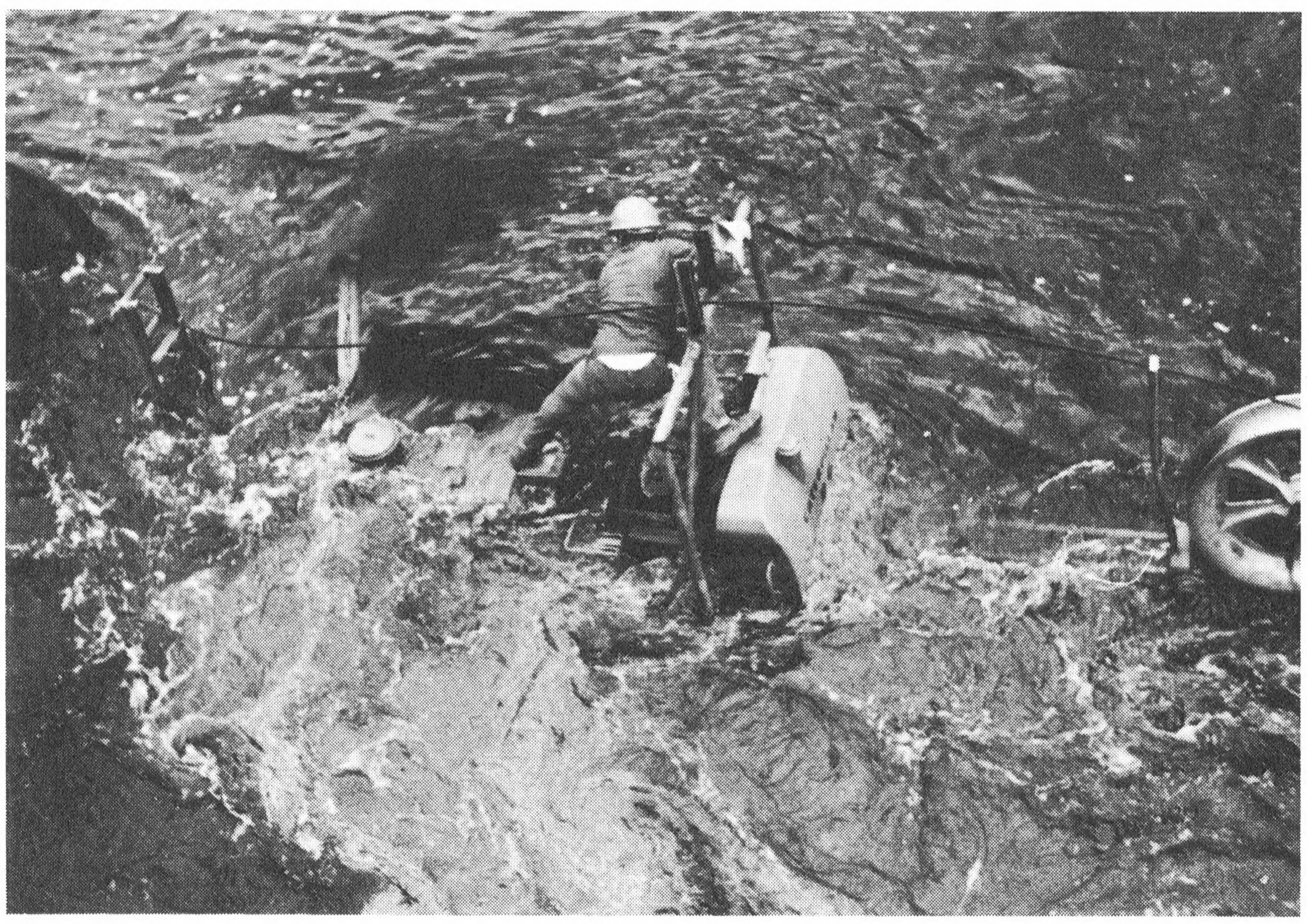
1966 was a most successful year in the buried cable program. By freeze-up, AGT had completed over 90% of their target with 7,660 miles of wire and cable ploughed in at a cost of some $10 million. Since the program began in 1964, they have buried 12,100 miles of cable.

During 1967, 48 projects requiring 2,982 miles of cable and 5,250 miles of wire will be undertaken. Estimated expenditure will be $10.8 million. A total of 8,000 subscribers and 4,000 potential subscribers will be added this year for four-party buried service.

Since the inception of this program, Northern Electric have been very closely associated with AGT through the supply of a substantial portion of the wire and cable requirements, as well as other associated equipment.

The AGT program has moved ahead so rapidly that the original target date for completion in 1976 has been advanced to 1973.

There are many factors to be considered in deciding what projects are to take precedence, and looking after the many arrangements which must be taken care of prior to actual plant replacement. AGT's Rural and Operations groups deserve a great deal of credit for keeping this massive rural project on schedule with the ultimate aim of achieving maximum customer satisfaction.

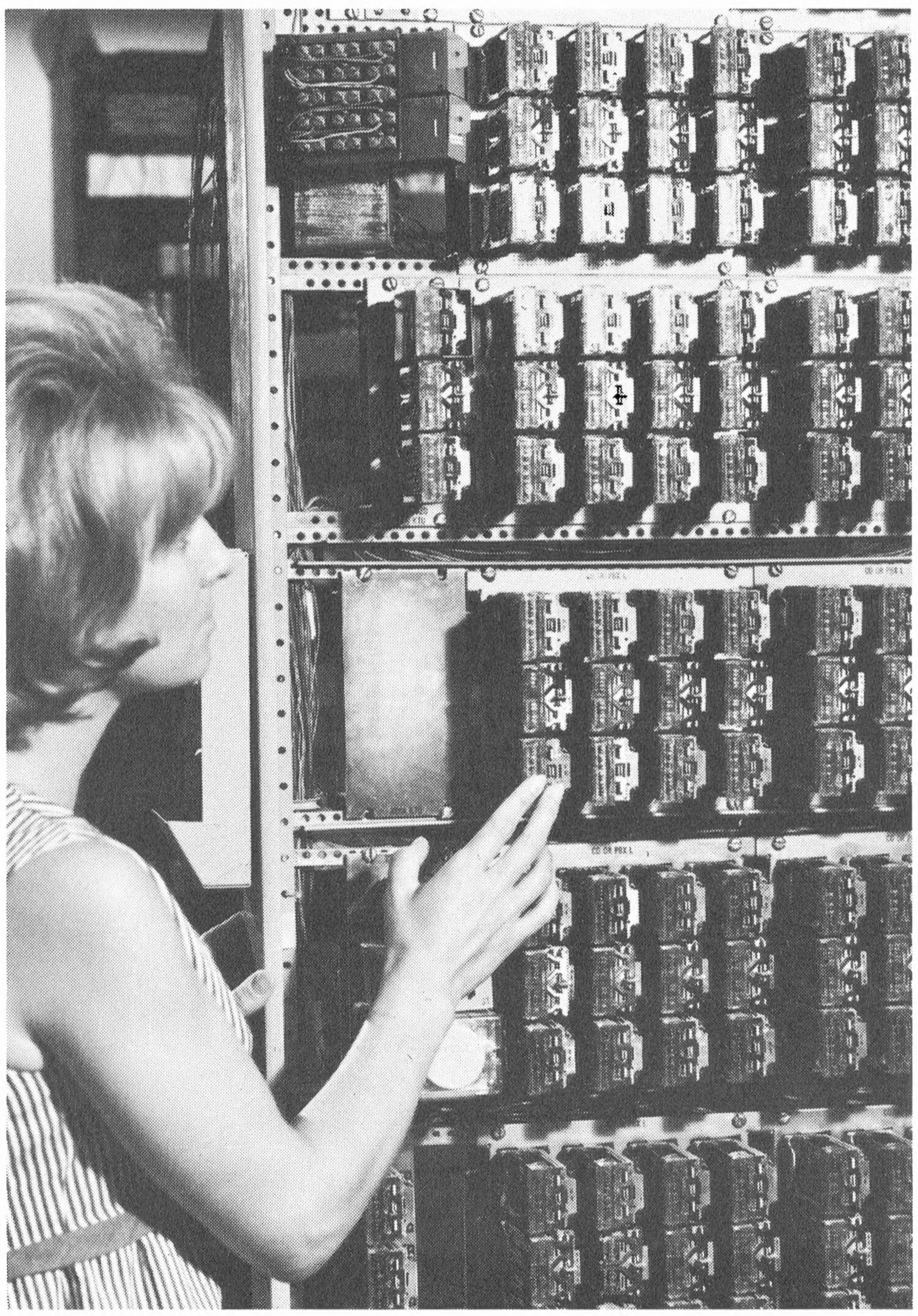


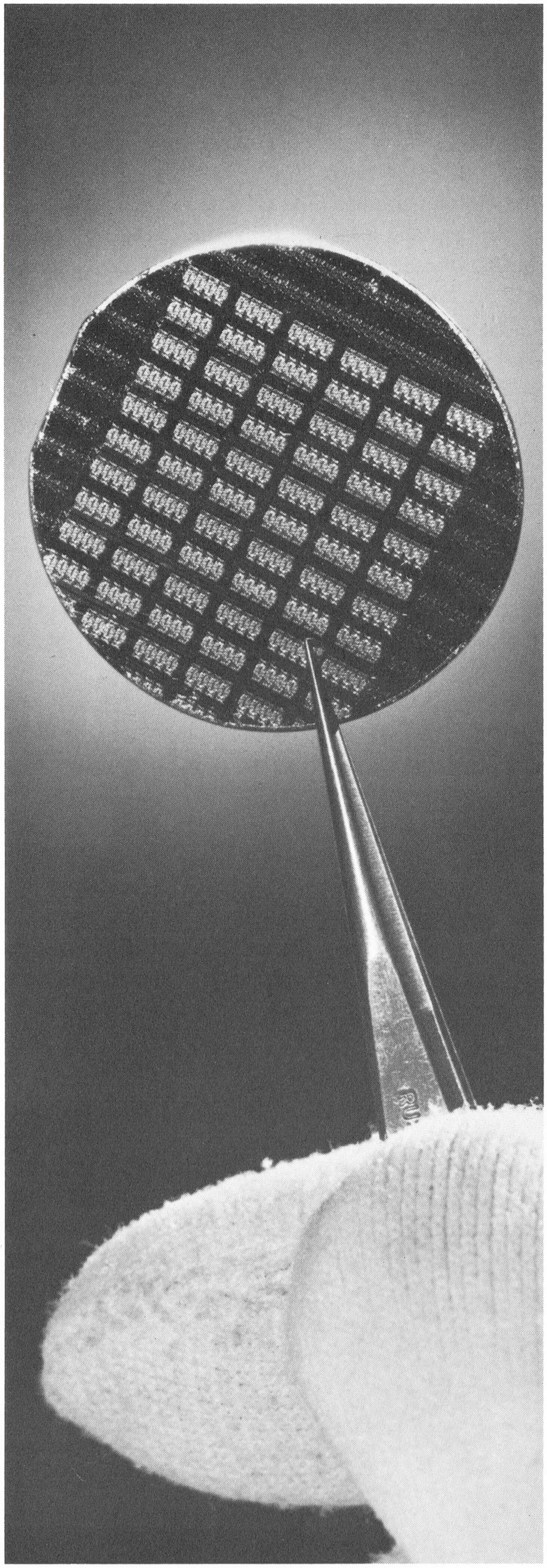
. . . on other occasions the going gets rough.

Large Scale Integration

by I. A. Davidson

A scientist at the Northern Electric Laboratories discusses the implications of this new technology and its impact on communications systems.





The logic complexity of this large bank of wire spring relays can be reduced, through LSI, to a single silicon slice measuring approximately one inch in diameter.

Silicon integrated circuits have now become widely accepted as basic building blocks in electronic systems. They are either in use, or are being considered for use, in all branches of electronics from the sophisticated computer to the common telephone. The reason for the trend is that these small components will do their job more reliably and at less cost than systems made from discrete components such as transistors, diodes, resistors and capacitors.

The key to the success of integrated circuits centers on one aspect of reliability in particular. There is always a risk of failure in an electronic system at the point where two dissimilar metals are joined — and there are many such places in even a small system. Consider, for example, just one lead of a transistor mounted on a printed circuit board. The copper on the board is connected by solder to the gold plated wire of the transistor. Inside the transistor, a join is made to another gold wire. This, in turn, is bonded to an aluminum pad which finally makes contact with the silicon chip. There are, therefore, about five interfaces in this small system, each of which is a potential reliability problem. Reduce the number of interfaces, and reliability improves.

Such a reduction is, in fact, achieved in an integrated circuit where all the components are included on a single slice of silicon. Such circuits have now been in operation for a considerable time and have clearly demonstrated their superior reliability.

This method of integration also reduces cost. Under the dual impetus of cost and performance, there has, over the past few years, been a major shift from discrete components to integrated circuits.

But has this shift gone far enough?

LSI AND THE YIELD BARRIER

The next logical phase in this development is called Large Scale Integration — the latest breed of electronic circuits. The LSI concept takes the integration process a step further by interconnecting a complete electronics system or subsystem on a single slice of silicon. Prior to the advent of LSI, as many as 200 individual circuits were fabricated simultaneously on a single silicon slice, measuring an inch or so in diameter. Each circuit on the slice (measuring typically sixty by eighty thousandths of an inch) was tested, scribed and bonded into a separate package.

With LSI, a great variety of different circuits is fabricated on the same silicon slice and interconnected to form a system or subsystem. There is no need to "dice up" various parts of the slice and place them in individual packages. The completed circuit slice can represent an electronic system, ready for interconnection with other elements.

A major limiting factor in the trend to LSI is the less than perfect yield that seems inevitable in the semiconductor manufacturing process.

Once the yield barrier is overcome, it is possible to build circuits containing as many as 1000 transistors with their associated resistors and diodes on a single slice of silicon.

Various approaches and techniques have been employed to solve this yield problem, ranging from ultra-clean processing techniques to sophisticated methods of introducing redundancy. At Northern Electric Laboratories, researchers have taken an intermediate approach in which redundant elements are processed, and the overall yield of the process is adjusted by the use of these elements. This is called Redundancy Adjustment of Probability, or RAP. In the RAP approach, more circuits than required are fabricated in such a way that despite the non-perfect yield, good circuits can be found ready for connection to the system. The interconnection between these circuits, instead of being on a printed circuit board is made right on the silicon slice, by depositing aluminum on the surface. This process is completely compatible with the semiconductor manufacturing process.

The increased circuit complexity in LSI, however, creates yet another problem. As each LSI slice becomes more specialized, the total number of any



A multiprobe testing device used to test circuits on LSI chips.

particular type is drastically reduced. This alters the economy of the process as the cost of the design of a particular system becomes significant in relation to the processing cost. One way of overcoming this increase in design cost is to utilize a computer during the design phase. This important subject is now being studied.

DESIGN PROCESS

The RAP technique has a big advantage in that the design of an LSI system can be carried out in the same way as the design of a conventional system that has printed circuit boards and individual integrated circuits. The same techniques can be used in the two cases with the same engineering effort. Experienced engineers can design the basic circuit blocks and the interconnection of these blocks. The design of the interconnection topology is analogous to the layout of printed circuit boards. Testing and inspection of the aluminum 'wiring' of the LSI system can be compared with the similar processes on a printed circuit board and the final test of an LSI unit is the same as the final test of a completed 'board'. There is, fundamentally, nothing new in the design procedure for LSI using RAP techniques. All the present methods in use with conventional systems can be applied to the new technology. The design cost of an LSI system should be no more serious a problem than with a conventional system.

We have just seen that LSI design and construction is similar in many ways to printed circuit boards with their associated components. But what form can these components take?

They can be circuits based on bipolar transistors (i.e. *pnp* or *npn* transistors) or they can be based on MOSFET (Metal Oxide Silicon Field Effect Transistor) technology that relies on conduction in the surface of the material. Both technologies are important, and the use of each depends on the particular application. Bipolar techniques are well established and they can be used to make high speed circuits, while the MOSFET technology produces slower circuits, but with a higher process yield and with a better immunity to stray electrical impulses. Whichever technology is chosen, the circuit can range from digital logic circuits to circuits for generating timing waveforms and amplifier circuits handling 'analog' or speech waveforms. The problems here are not peculiar to LSI but they do demand additional design rules. The overall problem is that of circuit design, and the choosing of the best designs and building blocks to achieve the required electronic function.

APPLICATIONS

Large Scale Integration is very much in its infancy but already many potential applications have been identified. One silicon slice can contain as many as 1000 transistors which, when connected together, form hundreds of logic gates. There are many items of equipment in a communications systems that are of such complexity as to warrant the use of LSI. One example is electronic data equipment associated with teletype systems or other digital data transmission systems. Another is the replacement of a mechanical logic system such as that which controls a group of key telephones. An LSI slice can form part of a high speed memory unit that is used with a very wide range of present day electronic systems. The number of possible applications in the vast field of electronics is limitless.

With LSI, a whole new technology is available to the electronic engineer. It is an exciting continuation in the evolutionary process affecting the semiconductor industry. Northern Electric is in the forefront of this evolution and looks forward to the benefits of LSI as it is introduced into the next generation of communication systems.

Barcelona ¡Ole!

by R. S. Long

N.E. succumbs to allure of Spain's ancient, thriving metropolis.

Mention Spain to a non-Spaniard and he is almost certainly bound to conjure up visions of lovely dark-haired senoritas; the colourful, fiery flamenco; the excitement of bullfights at fiesta time; and of a people caught up in the joy of living. These are the sights and sounds of Spain, and nowhere is the soul of Spain more apparent than in the beautiful Mediterranean City of Barcelona.

Imbued with artistic feeling and a profound freedom of expression, Barcelona possesses a wealth of spirit that is found in few of the world's great cities. Consider, for example, "Dia del Libro", a feast held in April of each year to celebrate books and flowers. On this special day, Barcelonese consider it their pleasant duty to purchase books by Miguel de Cervantes, genius of Spanish letters and author of the classic *Don Quixote*. Since it is also St. George's Day, in honour of Barcelona's Patron Saint, the whole city becomes a spectacle of red, white and yellow roses.

To delight the connoisseur of music and dance, there is Barcelona's Gran Teatro del Liceo, Spain's most important and one of Europe's leading centres for opera and ballet. Here also are Spain's centre of publishing, its art galleries and fashion salons. Barcelona is, moreover, a vast museum reflecting the influence of the ancient Romans and of ensuing periods in its colourful history.

Little wonder it is then that Barcelona is regarded as the cultural capital of Spain.

The profound duality of the Spanish people seems to spring from a splendid *joie de vivre* combined with what the Spanish themselves call " a tragic sense of existence". This blending of tragicomic elements is evident in the whole Spanish outlook, and accounts for that special sense of beauty found in things typically Spanish such as national dances and fiestas, the festivals of dust and flowers, and even their bullfights. Barcelona reflects this duality to a high degree.

Barcelona is also the heart of Spain's industrial and economic activity. It is not too surprising, therefore, to find that its *Official and International Samples Fair* is the greatest economic event of the year.

The first such fair was held around 1920, and was primarily devoted to toy industry exhibits. Today, it is far broader in scope, and has become a symbol of Spain's economic progress and a remarkable demonstration of its economic, industrial and commercial vitality. Add to these assets the unique spirit of Barcelona, and you have a result that is a wonderful visual spectacle, a feast of life and colour, joy and excitement.

It was against this backdrop that Northern Electric's first participation in the Barcelona fair occurred last summer. As part of a Canadian Government sponsored exhibit to promote industrial trade with Canada, Northern placed exhibits designed to acquaint the Spanish public, and particularly leaders of their telecommunications industry, with the Company's potential as a supplier of internationally oriented telecommunications products.

Northern's exhibit was manned by a five-man staff of research, systems engineering and sales experts. They and the Company were particularly gratified to receive from the Trade Fair Authority a special award for outstanding industrial innovation.

During the fair, which lasted from June 1st to 15th, several Canadian government officials from Madrid and Ottawa visited the Northern Electric exhibit, including Canada's Ambassador to Spain, Benjamin Rogers. Ambassador Rogers' favourable comments were particularly encouraging. These, and the number of serious product inquiries received from the hundreds of visitors to the exhibit, leave no doubt in our minds that Company representation in Barcelona was eminently successful.



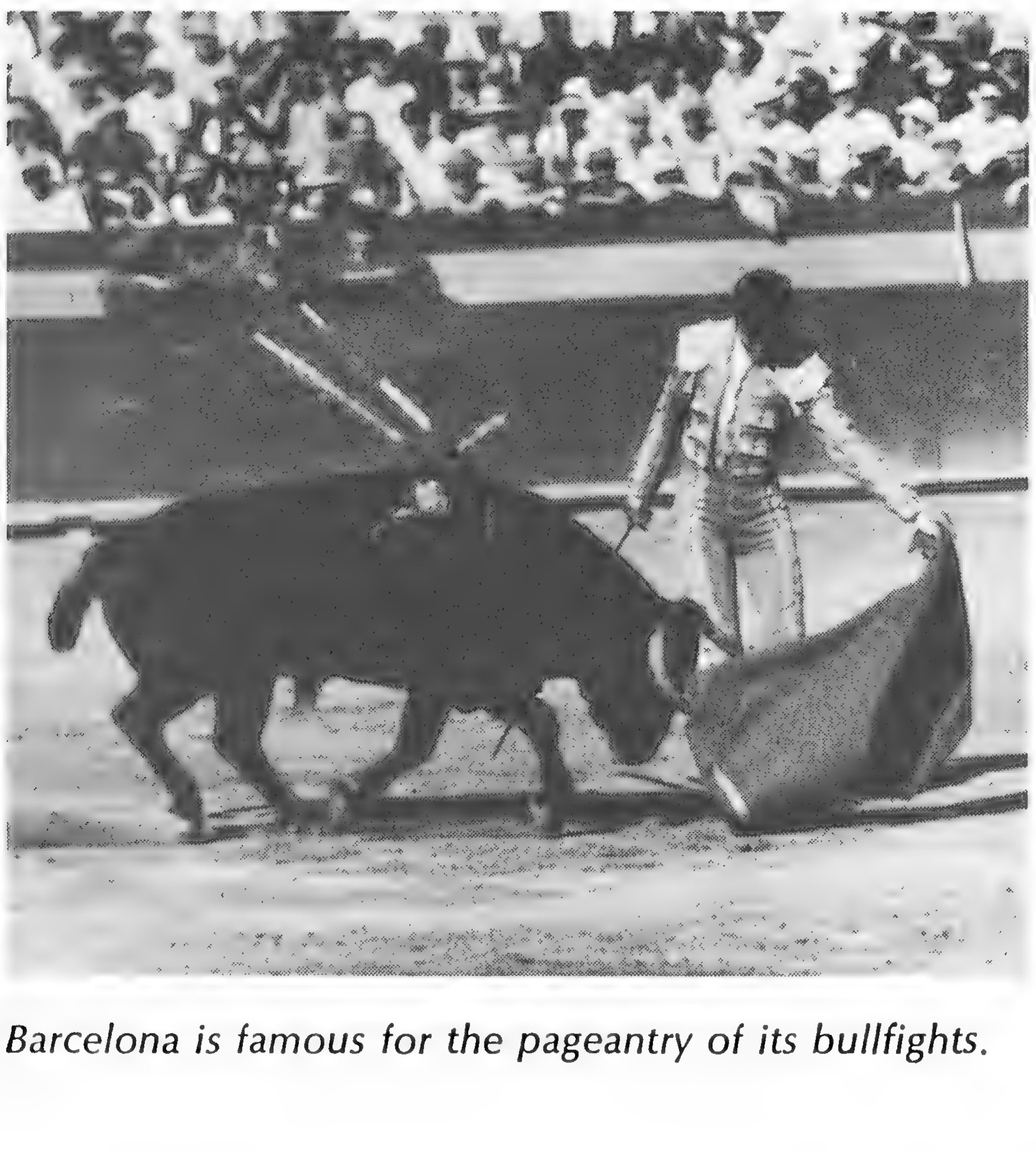
Benjamin Rogers (left foreground), Canada's ambassador to Spain, visits N.E. exhibit.



Young visitors were welcome . . .



. . . so were the more mature.



Barcelona is famous for the pageantry of its bullfights.



Monjuitch Palace, built for the 1929 Barcelona World's Fair.

The Electret Transducer

by W. H. Mantle

Thin metallized films, three ten thousandths of an inch thick, promise to revolutionize telephone microphones and receivers.

Ever since the invention of the microphone and loudspeaker, man has striven to improve the devices which convert sound into electrical signals, and electrical signals back into sound. The strides made in home entertainment systems are evidence that modern-day technology has wrestled with these complex problems and has won the battle for perfection in sound reproduction.

It is indeed surprising that one device that has not fallen under this axe of technology is the microphone or transducer commonly used in the standard telephone handset. First invented some 90 years ago by an English clergyman, Henry Hunnings, the carbon microphone has stood the test of time. Only now, with the advent of integrated circuits and a better understanding of the materials that can store electric charges, does it appear that the carbon device will have to make way for a microphone of a new and different type.

OLD AGE COMES TO THE CARBON

In principle, the carbon microphone is simple and rugged, light and portable and, most important of all, reliable. This may account for its widespread use and long life in the telephone industry. As the name implies, carbon granules are the key substance in the conversion of sound waves into electrical signals. The granules are closely piled in an insulated cup called a "button". The button is mounted so that it is always in contact with a diaphragm. Any movement of the diaphragm will vary the amount of pressure exerted on the carbon granules and thus the resistance through the carbon. Increasing the pressure causes the carbon to become more closely packed, thereby decreasing its electrical resistance to the flow of current. The variations in resistance of the carbon cause the current flowing through the granules to vary with the intensity and frequency of the sound waves. We not only have a very simple microphone, but also an amplifier as well, because the electrical energy output is greater than the energy required to produce the vibrations of the diaphragm.

But all is not rosy for the carbon microphone. It suffers from harmonic distortion, requires a great deal of electric current, in the order of at least 15 milliamps to produce a reasonable output, and suffers from a non-constant sound level due to the settling of the carbon granules. And the number of parts that go into the microphone is considerable by today's standards. Obviously, anything that overcomes these undesirable characteristics would represent a great improvement in telephone technology.

ENTER THE ELECTRET

In 1919, a Japanese Scientist called Eguchi stumbled on the principle of the electret microphone, that of permanently charging an insulating material with an electrical voltage. The insulating or "dielectric" material that Eguchi used was carnauba wax, solidified in the presence of an electric field. Keeping both sur-

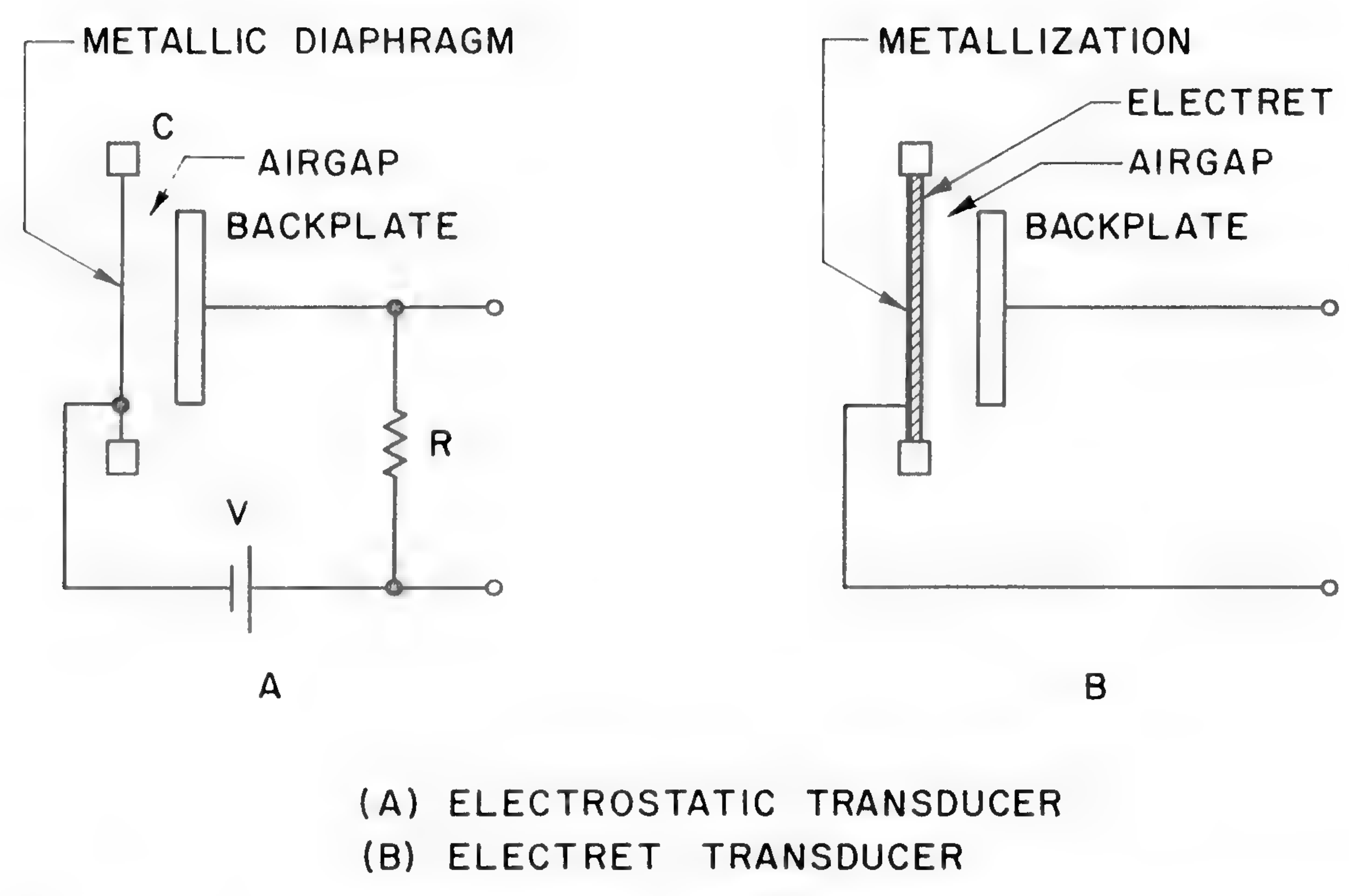


Figure 1 — Electrical schematics of electrostatic and electret transducers

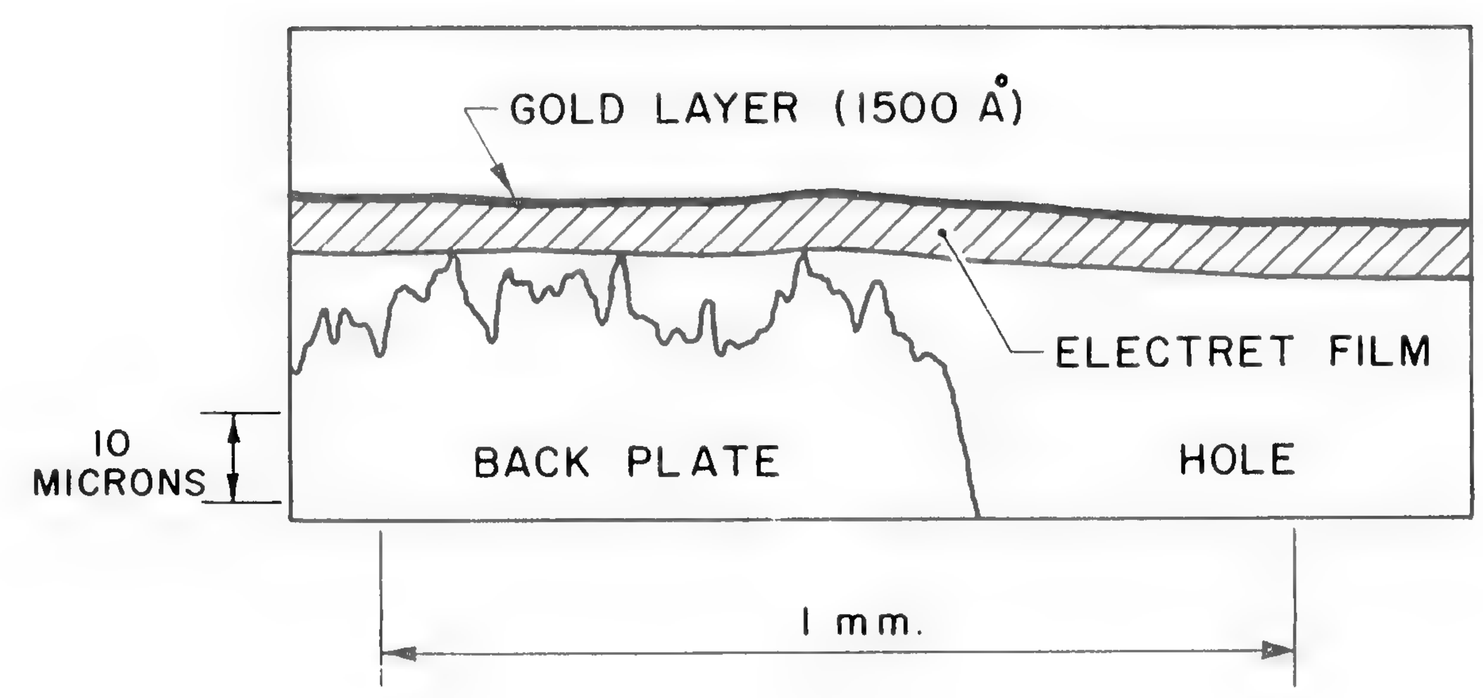


Figure 2 — Magnified cross-sectional view through the electret film and backplate

faces of the wax sample covered with metal plates that were shorted together, it was discovered that no measurable decay of the charge was detected for several years.

From these crude and humble beginnings, the electret principle has developed to a state where it can be applied to telephone microphones and receivers. Scientists now use various types of polymer materials that can be made into thin tough sheets approximately three ten thousandths of an inch thick.

The easiest way to explain the electret principle is to compare it with a standard electrostatic microphone, a high quality device in widespread use today. This electrostatic microphone, as shown schematically in figure 1(A) has a thin 'metal' diaphragm which can vibrate relative to a fixed backplate. An electrostatic field is set up in the airgap between the diaphragm and the backplate, with the aid of the external battery V and the resistor R. When the diaphragm vibrates under the influence of sound pressure, the capacitance C of the condenser varies accordingly and a voltage drop proportional to the variations of C is produced across the resistor R. This voltage drop is possible only if the time constant of the circuit is much greater than a period of the vibration of the diaphragm, because then the charge on the condenser, produced by the battery V, will remain essentially constant. Since the capacitance is equal to the ratio of the charge and the voltage on the condenser, a change in capacitance must be offset by a change in voltage. Conversely, when a variable voltage is impressed on the transducer, the diaphragm vibrates and this causes a sound wave to be produced. We therefore have a device which can be used not only as a microphone, but also as a loudspeaker.

The electret transducer as shown in (B) operates on exactly the same principles, except that here the electrostatic field, which is necessary to effect the transformation of mechanical into electrical energy, is due to the permanent charge held by the dielectric layer of the diaphragm. Notice that there is no external voltage applied to the electret — the permanent charge is on the film itself. The advantage of having a solid dielectric layer is that the capacitance of the system can be increased considerably without the danger of shorting the condenser. In practical electret transducers, the diaphragm is placed in physical contact with the backplate. The surface of the backplate is slightly roughened and the diaphragm is supported on many points as illustrated in Figure 2. The system can now be considered as a parallel combination of a large number of small electret transducers. The transducer consists simply of a metallized electret diaphragm, a conductive backplate and some means of making contact to the metallization and the backplate. As with the electrostatic microphone, the electret can be used either as a microphone or as a receiver.

HOW THE METALLIZED FILM IS MADE

It is quite obvious that the key to the successful operation of the electret microphone is the dielectric film which stores this electrical charge.

At Northern Electric laboratories, where an active electret microphone research program has been underway since 1962, a special type of polycarbonate material is used which is not available in sheet form.

The material is selected on the basis of its ability to retain a stored charge as well as various physical characteristics, since the film is stretched over a backing plate like an animal skin over a drum. The material is made by spreading a highly purified solution of the polymer on a glass plate, in a filtered and enclosed atmosphere, to prevent contamination from dust particles. After the solvent has evaporated, the film is annealed at a temperature of 150°C for approximately 17 hours. After this, the film is metallized by the evaporation of a thin layer of gold on one side only. The gold film is only 38 millionths of an inch thick and is so thin that it is partially transparent to light. In operation, the metal layer serves as one electrode of the electret device.

To transform this thin metallized film into a permanently charged electret, it is sandwiched between two electrodes and a high electrostatic field applied. Some outstanding research work has been done in this area with very promising results. Peter Fatovic has developed a new charging technique (patents pending) and Kees Reedyk and Dr. Martin Perlman have reported novel techniques for the measurement of this charge. (Editor's note:— the charging of the electret is somewhat technical and for this reason it has been omitted from this article. For these details, see Northern Electric's new technical journal TELESIS, Volume 1, November 1967.)

The selection of a charge which will permanently appear on the film is a trade-off between the sensitivity of the device and the required frequency response.

THE ELECTRET GOES TO WORK

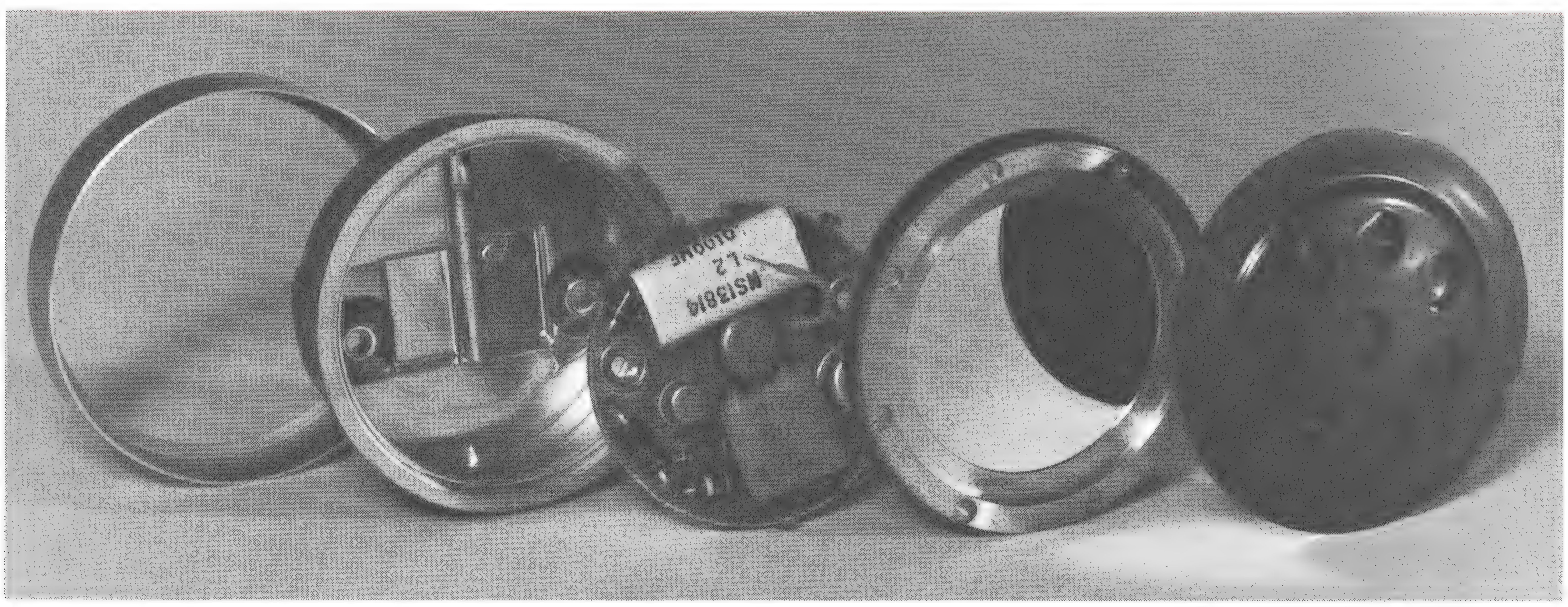
Once the metallized film is produced, it is stretched over a perforated metallic disc with just enough tension to prevent wrinkles. Tension is important here since the sensitivity of the electret is inversely proportional to the stiffness of the system. The perforated metallic disc aids in reducing this stiffness by coupling into the larger air volume behind this backplate.

To achieve a proper electrical match between the high impedance output of the electret film and the low impedance input of the telephone line, and to provide sufficient gain for successful operation, a simple preamplifier was designed.

An interesting side effect of this preamplifier/film combination is that the gain of the amplifier is practically independent of the length of the telephone line to the central office. The output signal, measured at the terminals of a telephone equipped with an electret transducer is thus approximately the same for long and short lines. In comparison, the output signal from a carbon microphone-equipped set is eight decibels lower when fed from a long line than from a short line. As the normal human ear mechanism can detect level changes of about three decibels, this represents a significant improvement over older microphone types.

As stated above, this permanently charged film could also be used as the dual to a microphone, that is a loudspeaker. By applying an electrical voltage to the film, it vibrates and produces an audible sound. Figure 4 illustrates both transmitter and receiver installed in a standard telephone hand-set. To drive the electret receiver, a voltage 100 times greater than that required for the standard moving armature receiver was required. This turns out to be in the order of two volts and produces harmonic distortion levels in the sound output of less than two percent. The frequency response of this receiver is flat from 50 to 5000 Hz.

An overall exploded view of the electret transducer showing left to right, the clamping ferrule, the cup, the pre-amplifier assembly, the backplate assembly and finally the protective membrane and screen.



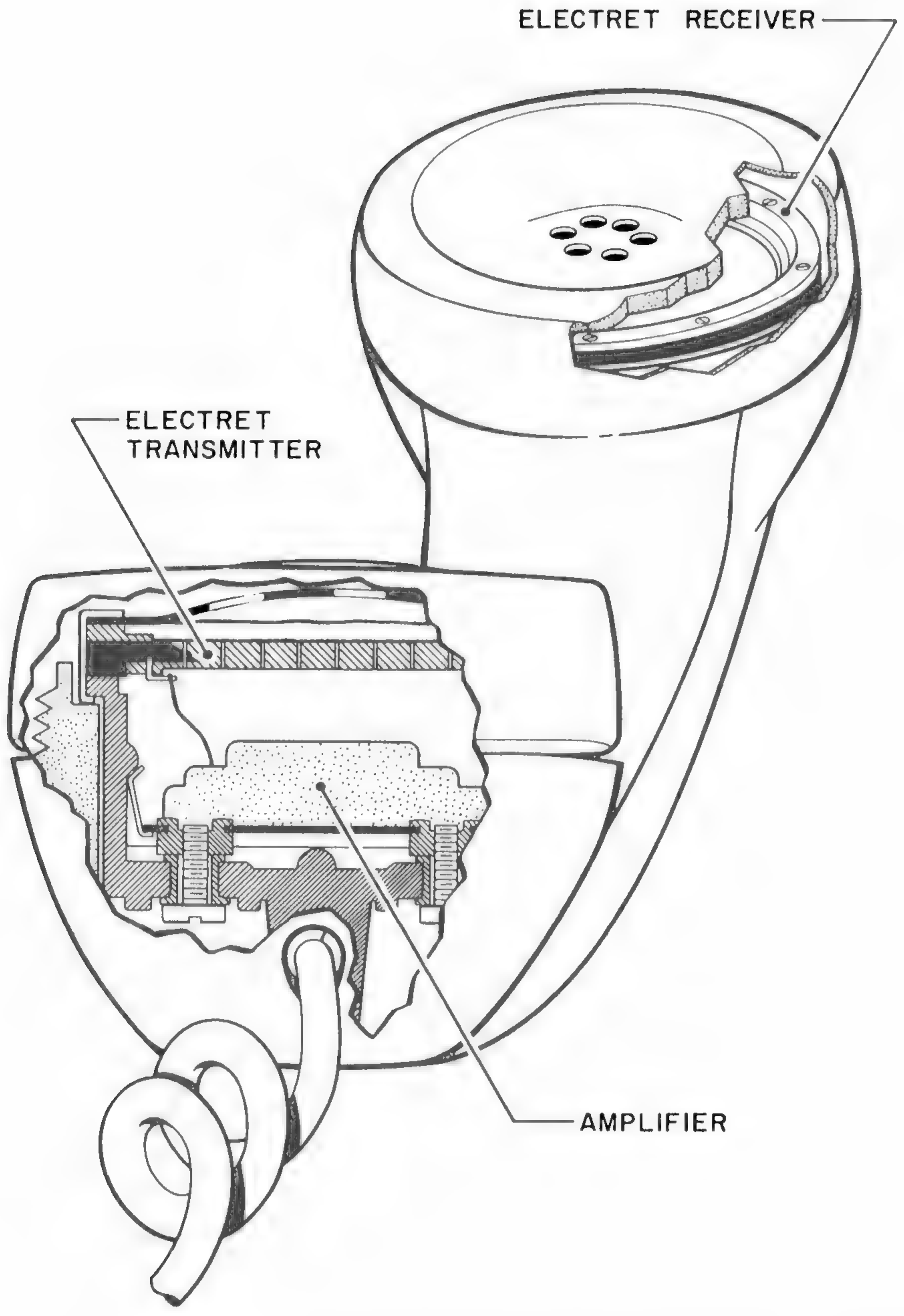


Figure 3 — Electret transmitter and receiver installed in standard telephone handset

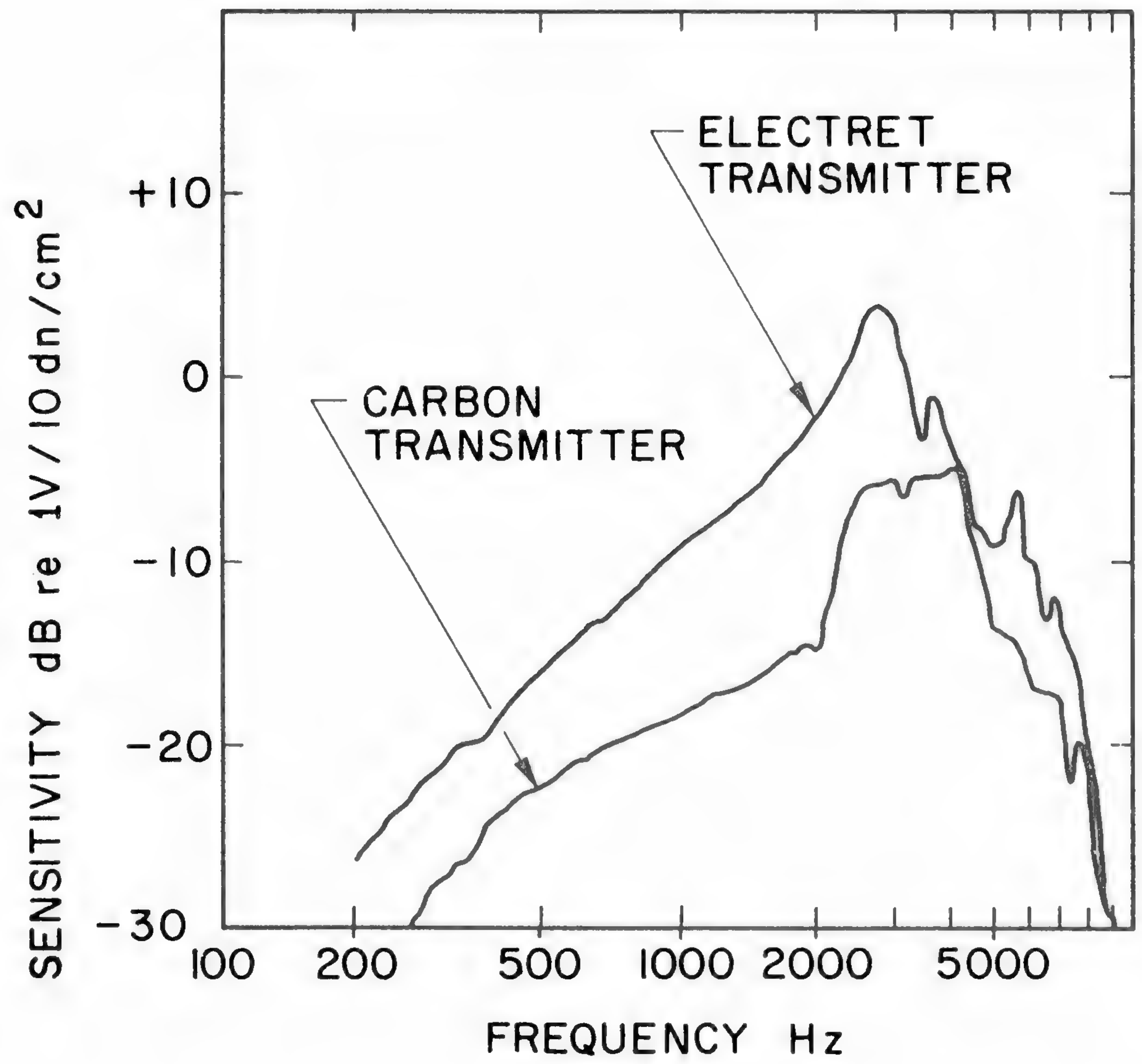


Figure 4 — Frequency response comparisons between carbon and electret transmitters

LIFE, HUMIDITY AND FREQUENCY RESPONSE

In order to evaluate this new transducer, the Physical Acoustics Department at Northern Electric laboratories have carried out exhaustive testing and analysis programs. Already, a limited scale field trial is underway to evaluate the durability of the electret transmitter under actual use.

The life of the electret, or the rate of decay of the charge on the film, is extremely important for application as a practical telephone transducer, because not only do we want a device with a long life, but one that is stable throughout its life. Based on charge decay measurements at temperatures ranging from 90°C to 175°C, researchers have extrapolated a life for polycarbonate materials which is in the thousands of years. In comparison with earlier materials tested, mylar microphones last only six months and teflon ones up to ten years.

Humidity is also receiving careful study. Experience with polyester electrets has shown a useful life reduction of 4 to 1 in humid atmospheres. However, if the degradation of the electret due to humidity is related to the water absorption of the material, then the latest polycarbonate materials are expected to perform much better.

In order not to distract from the purpose of the field trial, to test the life and durability of the electret, attempts have been made to make the frequency response of the electret transmitter identical to the

Placing the film into a polarizing fixture.





The polymer solution is spread onto a ground glass plate, prior to spreading into film form.

carbon transmitter. In fact the listener will hardly notice the difference except for the better intelligibility because of the lower distortion levels. Figure 4 compares the frequency response of the two transmitters. At high frequencies, it is identical for both types of transmitters, because the response is determined by the acoustics of the handset. The low frequency response of the electret transmitter is rolled off by the resistive input impedance of the amplifier. The carbon transmitter response has a broad maximum as a result of resonance of the diaphragm at approximately 2500 Hz and resonance of the front cavity in the neighbourhood of 3500 Hz. The electret transmitter has no diaphragm resonance. The peak in the response at 3000 Hz. is due to front cavity resonance alone.

It is not known at this stage in development whether electret devices will replace our present telephone transducers. What is known is that their simple construction (two or three major parts), performance (lower distortion), and adaptability to future electronic equipment and telephone sets (no current drain), as well as constant output over long and short telephone lines make electret devices an attractive possibility. This decision can only be made after the various parameters, involving both economy and performance, have been weighed.



Aerial view of Inkster Industrial Park in Winnipeg. Dotted white line indicates underground cable route. Arrow shows substation Number 24.

Winnipeg dispenses with overhead wiring by using

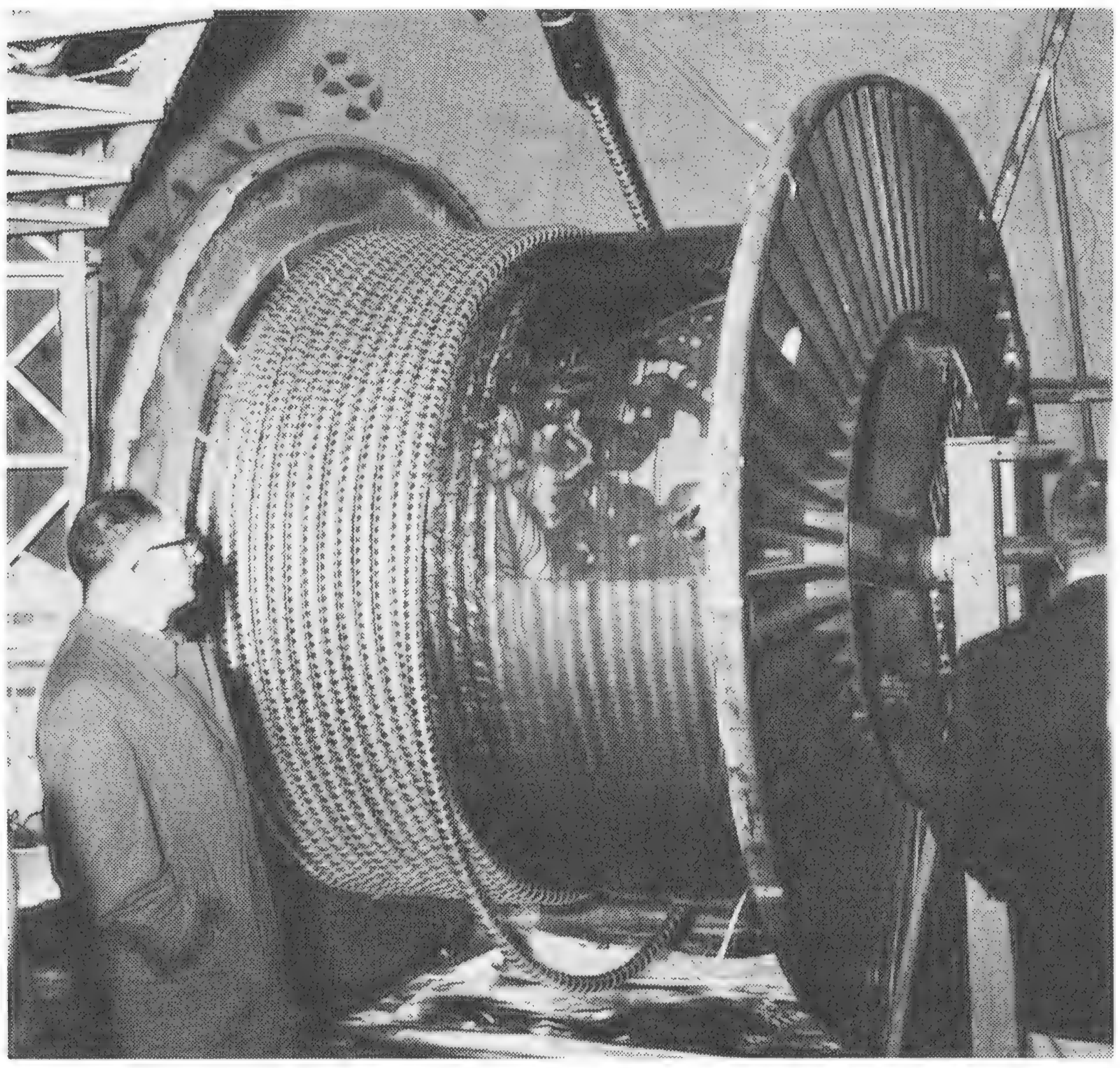
69KV Pipe Cable

by G. L. Goode

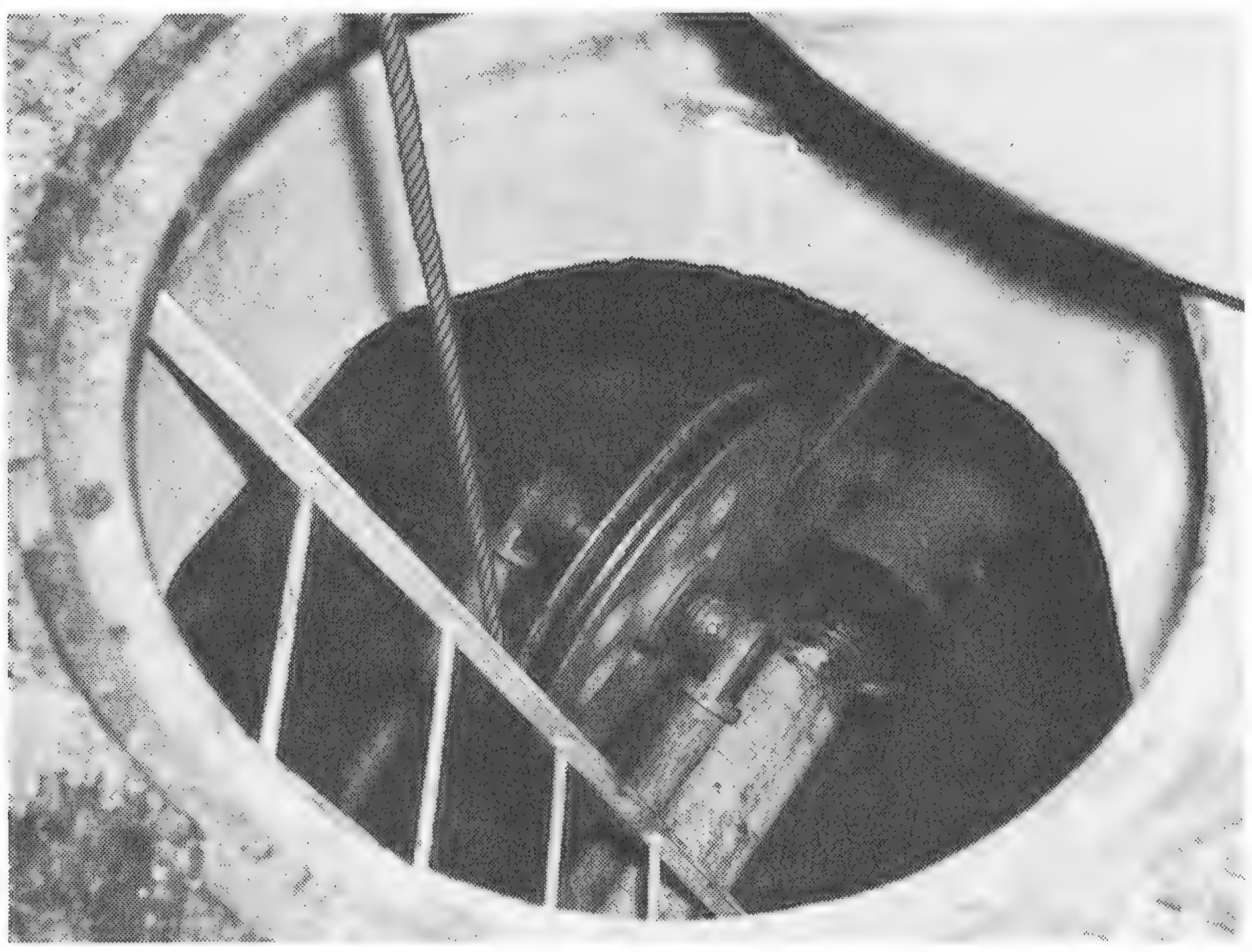
When the City of Winnipeg chose the site for its Inkster Industrial Park, it made a very wise choice indeed. Conveniently located on the northern outskirts of the city, the 600-acre site was selected because of its easy access to existing business and residential districts, as well as to major highways.

Inkster was established to provide a location for compatible firms in a planned industrial community. To maintain high standards of development, regulations on land use and buildings have been established to provide a harmonious blending of industries, one with the other, and with the surrounding community. These regulations are not overly restrictive, yet they provide long-range protection for every occupant in the park.

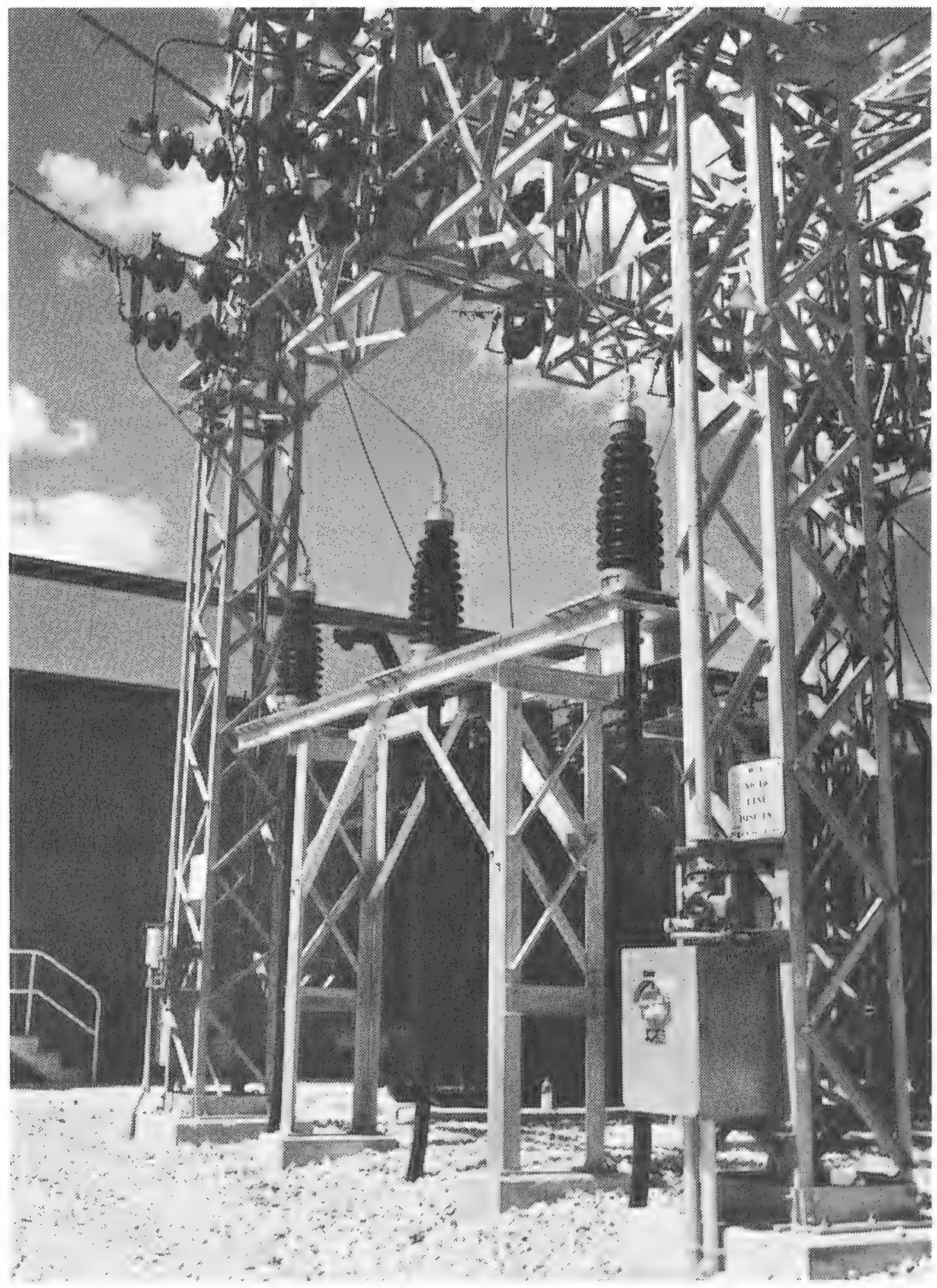
Since its opening, 400 acres have been sold for development upon which 44 industrial buildings have been constructed.



◀ *69 kv pipe type cable is uncoiled from reel and fed into a manhole.*



Inside the manhole, the cable is pulled through the underground pipe system.



Single conductor cables come up through the ground to connect with potheads and overhead disconnect switches.

It is not surprising, in view of such rapid development, that an increased demand for electrical power should result. It did in fact increase to the point where it was realized that the two substations supplying power to the area were no longer adequate. A new substation, designated Number 24, has therefore been constructed to handle all the power the park might need in the foreseeable future. Two 7,500 kva transformers have been installed, and these can be supplemented by a third of equal capacity should development of the area demand it.

Northern Electric was asked to perform an important role by supplying and installing a 69 kv pipe cable system to link Number 10 substation with the new Number 24. The length of this run is just over 8,000 feet, and the cable operates at 62.5 kv.

The cable route, although a simple one, passes through an already established residential community and, in keeping with the practice in new areas of dispensing with overhead wiring, Winnipeg Hydro chose pipe type cable.

This is the first high voltage pipe cable application to be installed in Manitoba.

All the industries in Inkster Park are fed through a system of duct lines and the bulk of the main feeder cables in the system are Northern Electric 5 kv PILC cables.

Progress through Power

Nova Scotia is involved in a chain reaction. It creates more electrical power to attract industry. Industry, in turn, expands and demands more electrical power.

"Progress through power" is the motto of the Nova Scotia Power Commission, the provincial crown corporation responsible for supplying electrical power and energy to the greater part of Nova Scotia. And progress in the industrial sector of the economy has finally reached this seagirt land with such gusto that the Commission has recently had to initiate capital programs at a record rate to keep the power picture pretty.

A spirit of optimism permeates Nova Scotia as it has not done for a hundred years. Until 1867, maritime trade made this province one of the wealthiest and most progressive areas in North America. But, with the turning inward to the vast, resources-rich but undeveloped country that was becoming Canada, Nova Scotia's fortunes declined. The road back has been a long one, and much of the progress achieved has been through electrical power.

From 1883, when the first generator churned out electricity at Black's Wharf in Halifax, until about 1950, provincial power generating authorities were engaged in a race to build enough capacity to supply the electrical needs of all Nova Scotians. Reserves were often strained to the limit, especially during the Second World War and the years immediately following it. Since then, however, the power industry has been able to cope with large industrial demands, while maintaining adequate reserves.

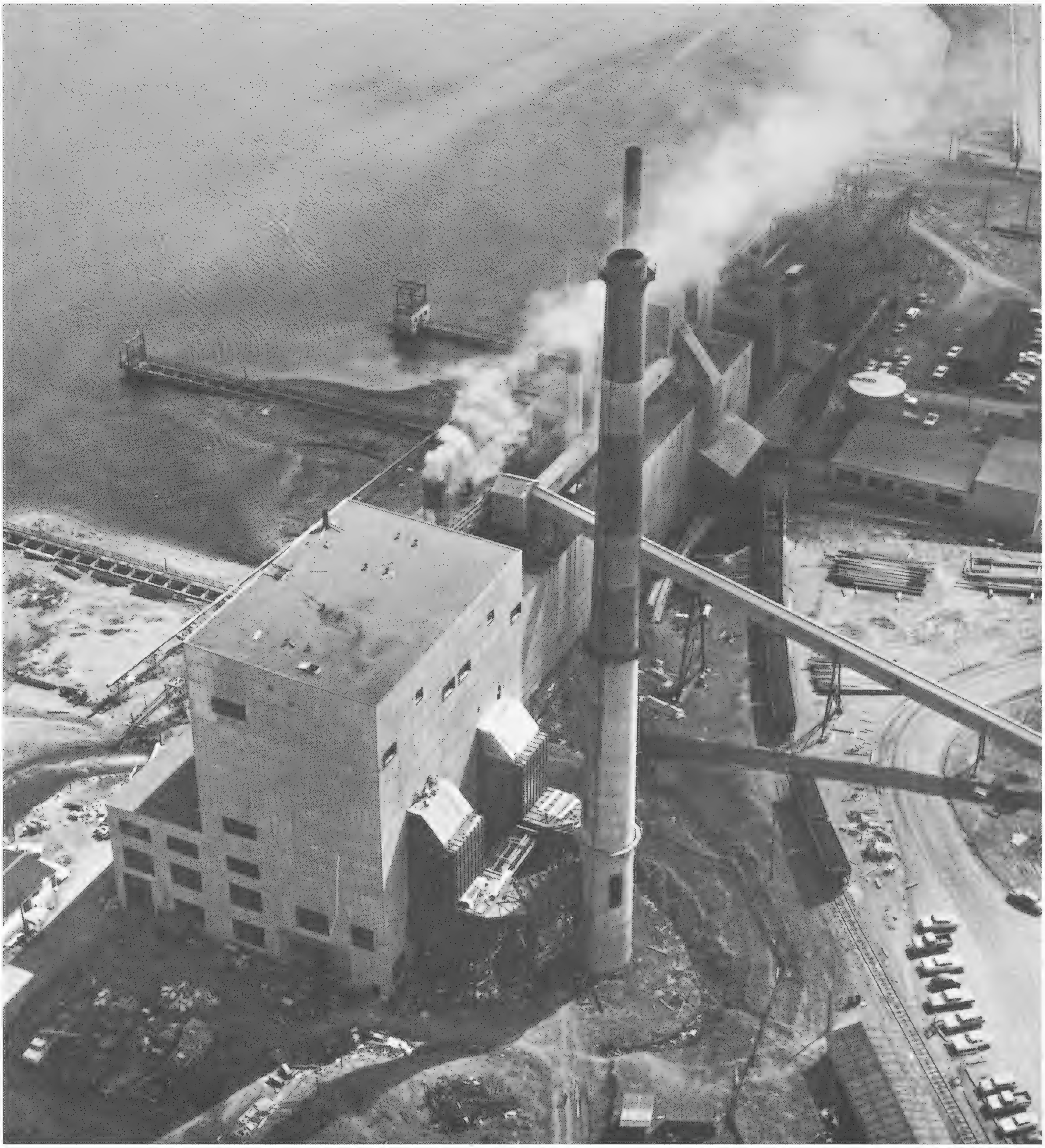
Throughout the late 1950's and the early 60's the Commission continued to develop hydro sites until most of the province's water resources had been tapped. In the last five years, emphasis has shifted to thermal stations, which define the Commission's terms of reference for the future, with the exception of a possible hydro development in northern Cape Breton — and the challenging potentialities of tidal power in the Bay of Fundy.

Water of another sort has been the spur to a building program which will have more than doubled the Commission's capacity in less than five years. When Deuterium of Canada announced plans to build a heavy water plant in Glace Bay, the Power Commission agreed to construct a $13 million topping turbine addition at the Seaboard Power Corporation Plant, then owned by DOSCO, to supply it with power and steam. In early 1966, the Commission bought Seaboard, which then consisted of 72,000 kilowatts of capacity in six machines, as well as associated transmission and substation facilities. Work on the addition was already well-advanced at the time of purchase, and the installation is now essentially complete.

The extension raises Seaboard's usable capacity to 110,000 kilowatts. Its Babcock-Wilcox & Goldie McCulloch boilers each make 550,000 lbs. of steam per hour, enough to produce 100,000 kilowatts of power and to pipe 290,000 lbs. per hour to the heavy water plant. The topping unit utilizes steam at 1,925 psig. at a temperature of 1,025°F., the highest steam temperature on any Canadian installation to date. At full capacity the boilers will burn 60 tons of coal per hour.

The new unit is referred to as a back-pressure set, which can be considered as a pressure reducing station using the "top" pressure steam to produce electric power as a by-product of the main operation, that is, providing process steam at approximately 600 psig. for the heavy water plant, and operating the four main conventional condensing steam turbo-generators.

With the completion of the addition, the old 600 psig. boilers at the Seaboard plant will be taken out of regular service, and kept on stand-by. However, the



Seaboard thermal generating plant near Glace Bay. The new section being added to the plant by Nova Scotia Power Commission will raise Seaboard's usable capacity to 110,000 kilowatts.

heavy water plant is scheduled to double production, and two of the 600 lb. boilers will be brought back into service to supply the additional steam requirements.

Operation of the plant is carried out from a centralized control room, with the control systems, recording instruments and indicators mounted on console desks. The desks are in a horseshoe arrangement, with electrical station and system controls on one side, the mechanical controls for feed pumps, turbines and boilers on the other. Attempts have been made to keep graphic information to a minimum, with emphasis placed on annunciation and audible "alarms" to direct the operator's attention where it is needed. Many of the instruments which display information graphically are also backed up by alarms. These steps have been taken to relieve the operators of the need for excessive concentration, since the number of variables over which he must have control is great.

The factors outlined here have virtually revamped station operation, making it a model of efficiency in every way possible.

Another project announced late in 1966 — an 80,000 kilowatt back-pressure generating station at Point Tupper on the Cape Breton side of the Strait of Canso — was conceived in the wake of plans to locate Canada's second heavy water plant in Nova Scotia. The news of the construction of the heavy water plant and of the associated Power Commission oil-fired thermal station at Point Tupper prompted British American Oil and Canadian Industries, Ltd. to locate respectively a refinery and a chemical plant in the same area. At the same time Nova Scotia Pulp, originally the only industry at Point Tupper, started to con-



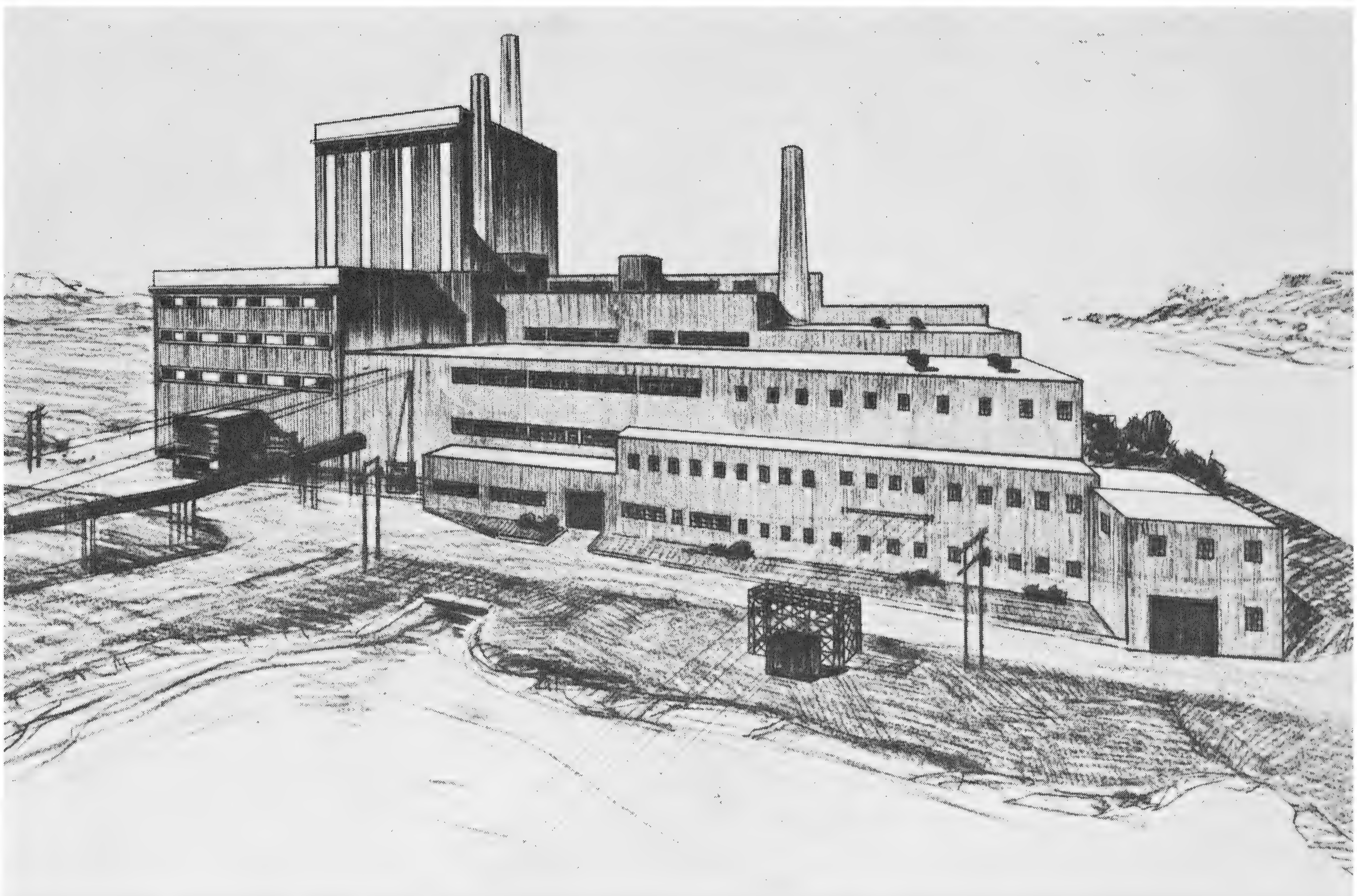
Bay of Fundy tides are legendary and many a tourist has boggled at the site of ocean-going ships high and dry, miles from the nearest arm of the sea. Tidal power is an equally captivating concept to power planners who are now studying the Bay with an eye to capturing millions of horsepower leashed in her strangely moving waters.

sider expanding its plant. As a result the Commission plant will supply process steam and/or power to a combination (and perhaps all) of these new industries.

Power for all this will come from what is considered to be the world's largest back-pressure turbo-generator, a $1,600,000 Stall-Laval turbine generator to be built by Canadian Asea. The new unit will also be the largest installation of a radial-flow turbine in Canada. The design, though not well-known in this country, has been used extensively for power generation applications throughout the world because of its high efficiency, compact arrangement and low installed cost.

It will be designed to operate at steam conditions of 1925 psig., 1,025°F., and a back-pressure of 185 psig. The maximum capacity will be 80,500 kilowatts, at a steam flow of 1,200,000 lbs/hours. The twinned generators will be air-cooled and have a combined capability of about 95,000 KVA at 0.85 power factor.

One of the principal advantages of the radial-flow design is its quick starting ability. The normal time for running a turbine of this size up to synchronizing speed from a cold start is five minutes. After synchronizing, the normal time for bringing it up to full load is approximately seven minutes. Under emergency conditions, the radial-flow turbines can be loaded at the rate of 37.5% per minute.



Artist's conception of the present 60,000 kw Trenton thermal generating plant including new 150,000 kw addition. When completed in 1969, the Trenton station capacity will be highest in Atlantic provinces. The $27 million plant will burn 400,000 tons of Nova Scotia coal per year.

The turbine's governing system will be electric-hydraulic, which suits the automated approach which is planned by the Power Commission. When the plant is completed, it will bring the total N.S.P.C. capacity in Cape Breton alone to almost 200,000 kilowatts.

Perhaps most interesting to note is the fact that when the 80,000 kilowatt unit is completed in 1969, the Commission will power the production of Canada's entire supply of heavy water, vitally important in the operation of the CANDU-type natural uranium nuclear reactor.

Eastern Contracting Limited of New Glasgow is constructing foundations and structures, while Canada Iron Foundries Limited, of Dartmouth is fabricating and erecting the steel. Montreal Engineering Company is the design consultant and provides engineering supervision at both this and the Trenton sites.

The largest of the Commission's projects is a 150,000 kilowatt thermal power station, now under construction in Trenton, N.S. This is the largest coal-fired thermal unit in Atlantic Canada, and the economies made possible by its size should result in considerably cheaper thermal power. The largest single condensing unit now used by the Commission, with 20,000 kw capacity, converts 14,000 BTU into one kilowatt of electrical energy. With the big new machine, the BTU rate will drop to less than 10,000 per kilowatt net generation. Under these conditions energy can be generated at a cost substantially less than is now possible.

The $27,000,000 plant will have the highest content of Canadian produced materials of any unit its size in Canada. Geographically, it is ideally situated from the point of view of supplying power on the Interprovincial Grid for all of Nova Scotia as well as New Brunswick.

The new plant will be an extension of the Power Commission's existing 60,000 kilowatt thermal generating plant at Cantley Point, Trenton, and when completed, will make the capacity of this station the highest in the province.

Foundations and structures are being done by the Waverly Construction Company, while steel fabrication and erection will be by Maritime Steel and Foundries, Limited. When on line in 1969, with economy thermal power, it should give a further boost to industrial expansion in the provinces.

Almost as a sidelight to its policy of modernization, the Commission is about ready to place in service a $1,400,000 extension to the Weymouth Hydro plant, used for peaking purposes, and plans to spend several million dollars more on extension to the 138,000 volt Grid system.

From bubbling heavy water to turning turbines, the Nova Scotia Power Commission remains several steps ahead of the quickening pace of Nova Scotia, providing further incentive for industrial development and expansion.

A New Technique for Splicing Aluminum Conductors

by Mary White

69 KV grounded, aluminum, segmental, impregnated, paper-insulated, oil-filled pipe cable is installed in Quebec City.

Oil-filled pipe cable systems are economical in construction, installation and operation, and are being used more and more to transmit electric power at high voltages.

The simplicity of these systems makes installation relatively easy, whether the terrain is flat or hilly; whether the cable route parallels city streets or crosses railroads and rivers.

Essentially, an oil-filled pipe cable system consists of three impregnated paper-insulated conductors placed in a corrosion-protected pipe, filled with oil maintained under a positive pressure. The oil under pressure and in direct contact with the insulation prevents voids from forming. This increases the dielectric strength and provides a greater factor of safety than some alternative types of cable.

Northern Electric has completed the installation of several of these systems. One of these, at Prince George, British Columbia, was described in the spring 1966 issue of the NORTHERN CIRCUIT.

Recently, Lachine Works in suburban Montreal designed and manufactured 14,000 feet of three-conductor 1800 MCM, 69 KV aluminum conductor cable for another of these systems in Quebec City. This historic city, with its congested streets, narrow right-of-ways and steep grades, was particularly suited for this type of installation.

In this particular system, the circuit required two pothead terminations and four splices for each of the three conductors.

However, as the cable conductors were made from aluminum, instead of the more commonly used copper, standard splicing techniques could not be used. This resulted in development at Lachine Works of a



new technique for splicing and terminating, using a M.I.G. (Metal Inert Gas) welding process.

In order to assure satisfactory fusion of the welding material to the conductors, it is necessary to remove all traces of oil from the face of each conductor. Gas flow is induced along the strand, using dry inert gas under pressure which causes the oil to flow away from the ends of the conductor leaving the face of the conductor oil-free.

The two conductors being spliced together are measured accurately and the surplus is sawn off so that the corresponding ends butt together.

The connector — a short aluminum sleeve — is slipped over the ends of the conductors being spliced so as to enclose an equal length of each, then compressed and cut to critical requirements which have been set up to assure a good weld.

Using the M.I.G. welder, the ends of the connectors are "buttered" to form a mechanical bond and oil seal.

Both connectors are then placed in a special jig and the gap between them gradually filled with weld material.

After the conductor has been allowed to cool, it is filed and sanded to a smooth finish. This procedure is repeated for the other two conductors prior to commencing the taping operation.

Terminating of the conductors in the potheads is carried out, using similar principles.

This year a pipe cable system with smaller aluminum conductors was installed in Winnipeg, Manitoba, and the same procedure for splicing the conductors was used. *(See 69 KV PIPE CABLE, page 19)*

The welding of aluminum conductors in high voltage cables has been proven possible, providing one has the proper materials, equipment and experienced personnel.

Gold River

by Donald Stainsby

Electric heat, and absence of utility poles distinguish new B.C. town.



Gold River townsite seen from the air.

Canada's first all-electric town is rising on the west coast of Vancouver Island — in the most historic part of the Pacific province.

The town is called Gold River. It is rising near the shores of Nootka Sound where, in 1778, Capt. James Cook became the first white man to set foot on what is now British Columbia.

Although there are no restrictions on residence, Gold River is being built primarily to provide first-class urban living that will attract employees to the $60 million, 750-ton-a-day bleached kraft pulp mill being built by the Tahsis Company Ltd. of Vancouver, just nine miles away.

Incorporated under forward-looking new provincial legislation before it had a single resident, Gold River is a self-governing district municipality that includes the pulp mill. Since the mill went into operation last summer, some 2,000 people have moved into the Gold River development.

These people own their own split-level or ranch-type houses, rent apartments in block or garden-type developments.

They shop in a commercial centre patterned after a cosy village, complete with town square.

Their children will attend schools of revolutionary design equipped with the most modern teaching facilities.

And when they look down the curving, curbed streets and over the many park areas, they will not see a single pole.

That Gold River would be a town without poles was decided early in the planning, largely at the request of Tahsis president J. V. Christensen, a man who hates the sight of power poles. In Gold River, all services are underground — telephone, electric and television cables.

A logical extension of this kind of thinking led to the adoption of electric heat as standard for the new community.

Careful study of various heating methods was made by engineers of the Tahsis Company Ltd. and of McCarter Nairne and Partners, the architects and consulting engineers who are managing the planning and construction of the new town.

Electrically heated subdivisions in similar climatic areas in British Columbia and the neighboring American states of Washington and Oregon were checked for the system's efficiency and economy. B.C. Hydro, which assisted greatly with the studies, provided cost projections.

Electric heating systems were installed in the first subdivision of 44 houses occupied in October 1965. Since then, more subdivisions, with an overall total of 218 houses, have been completed. All were designed for electric heating.

Significantly, the first two major investments of private capital in the new town — an apartment complex and a hotel — specified electric heat.

All this activity, despite the care taken with planning, has proceeded at a breakneck pace dictated by circumstances.

The creation of Gold River was sparked by the Tahsis Company's expansion plans. In April of 1965, the East Asiatic Company (Canada) Ltd., a subsidiary of the worldwide Danish trading firm, was joined as equal partner in the ownership of Tahsis Company by Canadian International Paper Company, the largest subsidiary of International Paper Company, one of the world's leading pulp and paper firms.

The partnership was arranged to facilitate the construction of a pulp mill on tidewater at the mouth of the Gold River, a site close to the source of wood supply where adequate docking can be provided for ocean-going freighters.

The location had one drawback — the closest established town was Campbell River, 60 miles away on the east coast of Vancouver Island. It was obvious that, if the mill were to attract skilled employees who



Absence of telephone and power poles gives a clean look to these Gold River homes.



Backbone of the new town is the 750-ton/day pulp mill located 9 miles away on the west coast of Vancouver Island.

are in great demand in B.C., first-rate living facilities would have to be provided nearby.

An excellent site was found just nine miles from the mill, where the Gold River canyon opens out in a wide, mountain-fringed but slide-free valley at the confluence of the Gold and Heber Rivers.

Location of the townsite there has already produced major changes in the previously semi-isolated northwestern coast of Vancouver Island.

Although Nootka Sound was the centre of the 18th century sea otter trade with China, and was the cause of a heated controversy that nearly led to a war between Britain and Spain, it has rested in semi-obscurity since the early part of the 19th century.

Logging and fishing camps were built along the shores of the deep inlets, and a gold rush occurred at Zeballos in the 1930s, but, until now, the only consistent industrial development had been that of the big Tahsis Company sawmill in the town of Tahsis. (The mill cuts about 140,000,000 fbm a year and exports all its product to world markets.)

First rumblings of change came in 1959 when the Tahsis Company pushed its logging road through the Gold River canyon to connect its three farms with logging roads that led, to provincial highways. But, as with all logging roads, use of this road by private vehicles was necessarily restricted, and the general public knew little of the Nootka Sound region.

Then, in the interests of good forest management and of the full utilization of the wood on its tree farm, the Tahsis Company decided to start producing pulp. The pulp mill and the new town followed.

As the new townsite of Gold River arose and rapidly took shape above the inevitable construction mud, bustling crews of wiremen representing a variety of electrical contracting companies moved in to install many of the electrical components that go into a modern electrified community. Out of the well stocked Vancouver warehouse of Northern Electric streamed electrical goods of all kinds, including the familiar blue cable reels.

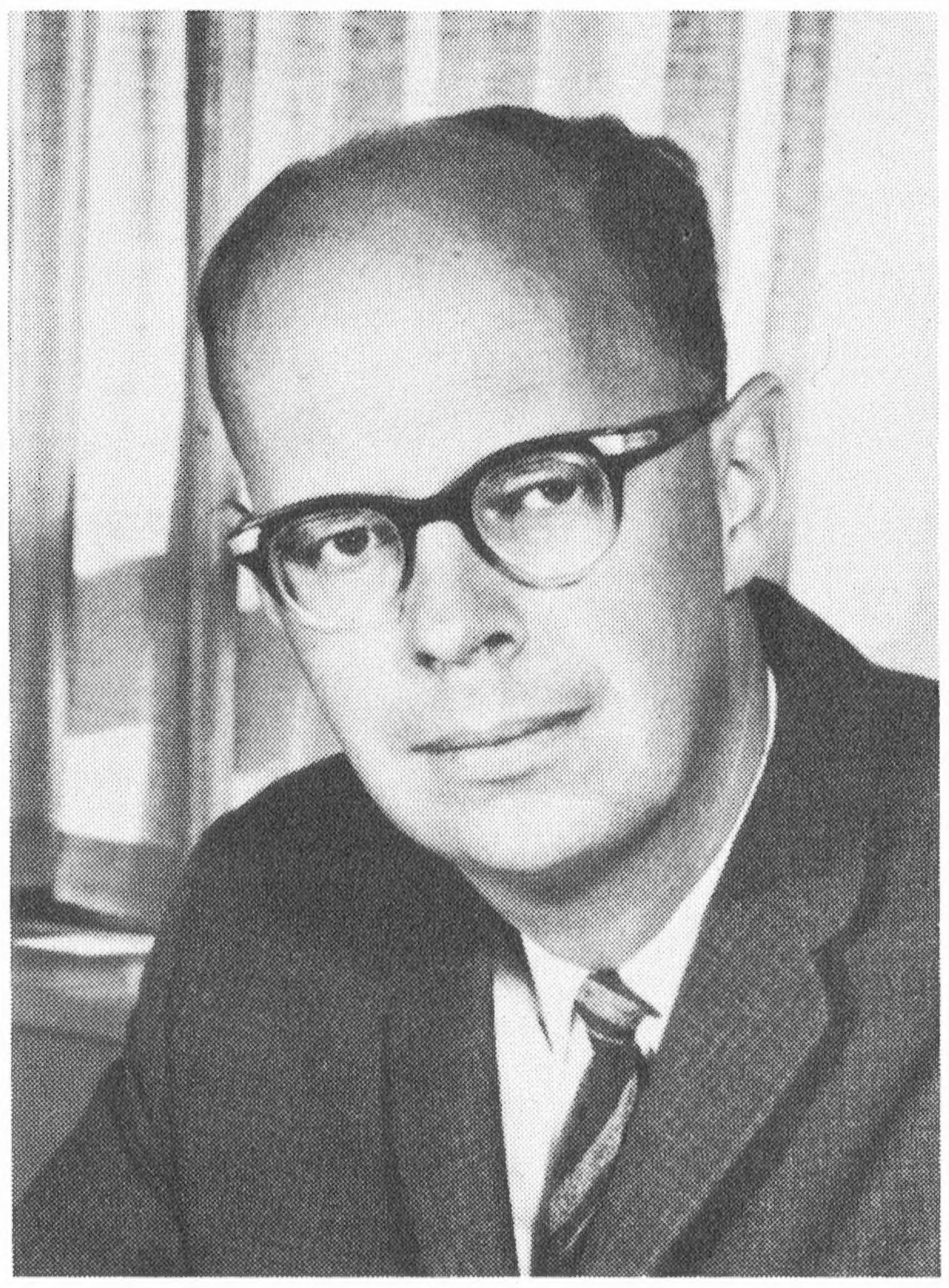
At the new Tahsis Company pulp mill site, Electrovert HLA heavy duty ladder tray supplied through Northern Electric grew into latticed pyramids. As the tray disappeared into the new buildings and was formed into sturdy and spacious cable support systems, a forest of blue reels sprang up beside the rapidly melting piles of tray: bright red jacketed 15,000 volt butyl rubber cable to provide primary distribution through the mill; soberly brown jacketed 3,000 volt Teck cable to supply the large 2,300 volt motors; gleaming black jacketed Teck cable to feed the multitude of 600 volt mill motors.

As electric cable and other building materials find their end use, British Columbia gains a new paper mill and a new town: Gold River.

PEOPLE



J. R. Houghton



J. B. Hutchinson

Northern Electric Company, Limited announces the appointments of J. R. Houghton as vice-president, corporate development, reporting to the president, and of J. B. Hutchinson as vice-president, Montreal manufacturing, reporting to the executive vice-president, operations.

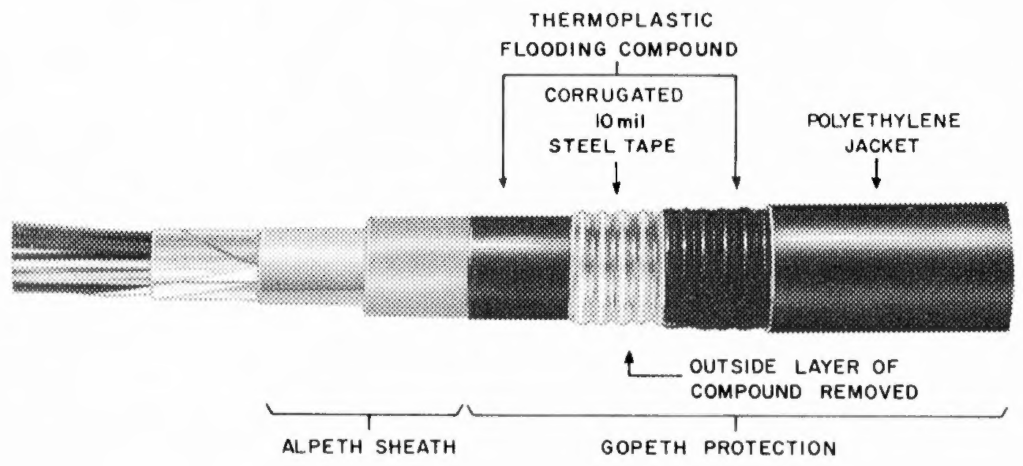
Mr. Houghton joined the company as an engineer in 1935, following graduation from McGill University. In 1959, he was appointed manager, London Works. He was made a vice-president in 1961, and became vice-president, Montreal manufacturing in 1965.

J. B. Hutchinson, who succeeds Mr. Houghton as vice-president, Montreal manufacturing, is a graduate in Applied Science, University of British Columbia. He joined the Company at Montreal in 1943.

In 1962, he became manager, London Works. He returned to Montreal in 1965 as assistant vice-president, information systems.

PRODUCTS

GOPETH* PROTECTION



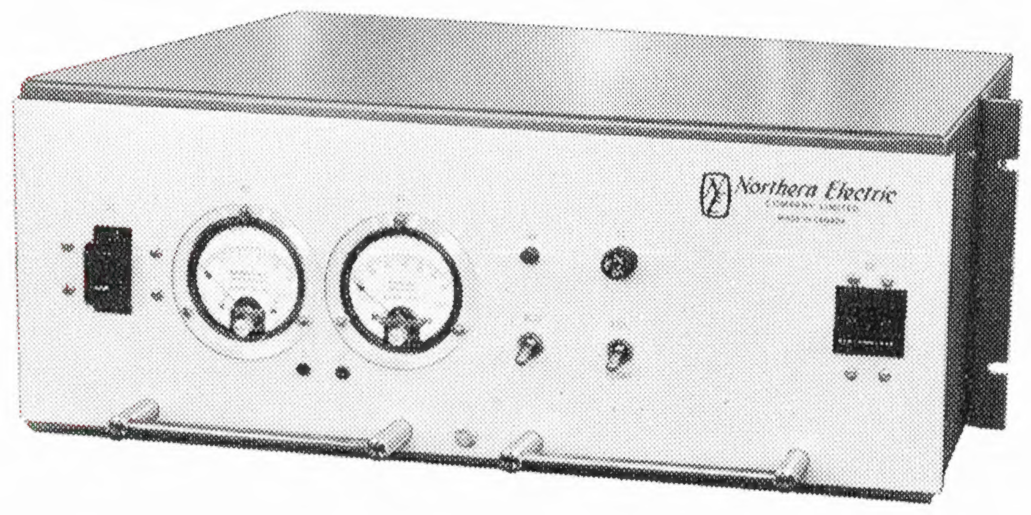
GOPETH Protection provides a most effective safeguard against rodent attacks on buried or aerial cable. It consists of a longitudinal 10-mil corrugated steel tape applied over any Alpeth-, PAP-, Stalpeth-, or PASP-sheathed cable, a thermoplastic flooding compound applied to both sides of the steel tape, and a high-quality polyethylene jacket. This unique design also gives protection against damage from mechanical stress and frost heaving. The GOPETH protected PAP- or PASP-sheathed cables are recommended for areas of high lightning incidence.

The 10-mil corrugated steel tape has a crush strength at least equivalent to that of standard gopher tape armour (GTA). As well as providing complete gopher protection, the steel tape provides impact and crush resistance to cable installed in rocky terrain.

GOPETH Protection can be supplied on cable with outside diameters ranging in size from .650 inch to approximately two inches.

*Trademark of Northern Electric Company Limited.

48-VOLT SILICON CONTROLLED RECTIFIERS



These battery-type rectifiers, utilizing transistor control circuitry, are highly efficient silicon controlled power supplies.

There are three models available, providing 48 v d-c outputs of 12.5, 25 and 50 amperes respectively, and they can be used in Private Branch Exchanges or Electronic Switching Systems, or with any communications power plant where size and capacity comply with requirements. Control circuitry is identical for the three rectifiers and is provided as plug-in cards. All models are designed to operate from a nominal 115- or 230-volt, 50- or 60-Hz a-c supply. The rectifiers are voltage regulated within one per cent for load changes from zero to full load, for line voltage changes of $\pm 10\%$, for frequency changes of $\pm 5\%$, and for operating temperatures between $-20°C$ to $+60°C$. Recovery time to load and input changes is 60 milliseconds. The voltage range is adjustable between 44 to 60 volts. Ammeters, current limiting d-c filtering, blocking diodes, voltage output jacks and automatic shut-off are provided. Voltmeters and low-voltage indicators are optional features.

All three models fit 23-inch relay racks and are 15 inches deep. In height, they range from 8 inches for the 12.5-amp model to 24 inches for the 50-amp model.

Every component in these reliable units is designed, both mechanically and electrically, to ensure long life and trouble-free operation.

QTH8A TOOL



The QTH8A tool is a 6-inch, double-end socket wrench for use on hexagon nuts, 3/8″ and 7/16″ across the flats. Constructed of case hardened steel with a zinc chromate finish, the tool is designed for use on the locking devices of cable terminals, closures and cabinets; for fastening ground clamps, connecting blocks and terminal blocks; and for connecting wires to fuses and binding posts.

Our record stacks up!

Time and time again, when cable has been required for a special and unusual application, Northern Electric's vast experience in the field of cable design and manufacture has met the need.

You, too, can benefit from Northern's competence gained from more years of cable manufacture than any other Canadian Company.



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